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OUR COVER

This month's cover picture gives a general view of the small 5-watt amplifier described on Page 4 of this issue.

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Microgroove to the Fore

The welcome news has recently come through that the largest gramophone record company in the United Kingdom is soon to begin issuing microgroove records. Just what kind of microgroove records has not been stated, but it is a pretty safe bet that some at least will be 33⅓ R.P.M. ones, similar to those on the market already in England and in this country. A question which will be of much concern not only to those who play records, but also to those who market the equipment for doing so, is whether or not 45 R.P.M. discs will make their appearance too. It might be regarded as significant that some of the British and Continental makers of record-playing equipment have for some time being marketing players and automatic changers which included 45 R.P.M. as well as 33⅓ and 78. There could, however, have been several reasons for this, not the least being the export market in Canada and the United States, where all three speeds have been flourishing for several years now; alternatively, these manufacturers may have been astute enough to realize that since the major British record-making concern had not yet elucidated its view on long-playing records, there was always a distinct possibility of three-speed equipment becoming essential all over the English-speaking world. Of course, there is no guarantee that 45 R.P.M. records will come from British manufacturers, even after October, but it does seem reasonable that the so-called "battle of the speeds," as it was called in America, might have settled itself down into a policy of "live and let live." The reason for this is to be found in the fact that even the small, ten-inch 33⅓ R.P.M. recordings have too long a playing time for short pieces and ephemeral popular items. This is where the 45 R.P.M. record may well come into its own, if it has not already done so. We may yet see very small 45 R.P.M. records, similar in all respect to a popular 10 in. 78 R.P.M. record, except in pressing material and size. Should this happen, the distinction between "long-playing" and "standard" will no longer be a real one, because the 45 R.P.M. disc will really be a fusion of the best points of the 78 and 33⅓ varieties.

It should be pointed out that by no means the only advantage of the L/P record as we know it today is its long playing time. Perhaps the greatest advance is the use of vinylite as the pressing material, with its extremely low noise level, its light weight, and its "unbreakability." Then again, the past difficulties that were encountered in making slow-turning records have been, in the main, overcome, and not only to the extent that a 33⅓ R.P.M. record can be made to have as good quality as its 78 R.P.M. counterpart. The quality of the new records can be, and frequently is, better than that of the best conventional recordings, and we are indeed fortunate to have gained so much at one fell swoop, as it were. It is doubtful, moreover, whether L/P records would have had such instant acclaim throughout the vast company of lovers of recorded music had they no more to offer than their increased playing time.

An indirect advantage, which we have had reason to mention before in these pages, is that with the long-playing records has come a whole crop of pick-ups with vastly improved characteristics than their counterparts a few years ago. We certainly have the L/P record to thank for this. The "powerhouse" pick-ups to which we resigned ourselves in the past, not being millionaires, and able to afford the sort of thing the Broadcasting Service used at the same time, would have played a modern L/P record once (assuming that the correct sized stylus had been fitted), after which the record would have been fit only as a hoop for the children! Any pick-up that will make an even passable job of an L/P record is infinitely superior to the pre-war ones which we suffered, simply because there was nothing better.

Then again, along with the new records have come better ways of making records. These had to be invented in order to make the L/P disc a practical proposition at all. Tape recorders, which seem to hold pride of place in the recording world where quality of reproduction is the major necessity, have to a large degree done away with the necessity for recording directly on to a wax master. The flexibility of tape must have resulted in many improvements in the technique of record making, all of which will ultimately be passed on to the consumer, and some of which have been already. Who does not remember some of the recordings of big works, taken from "live" rather than studio performances, in which the "cuts" between one side and the next were atrociously made, without reference to the musical content? The L/P record does away with all such, and many other defects. No longer need a crashing climax, that has been working up over half a side, be cut off in its prime so that we can turn the record over! Nor will we have to juggle with the volume control so that the output level on side 2 of something will sound something like what we got from side 1.

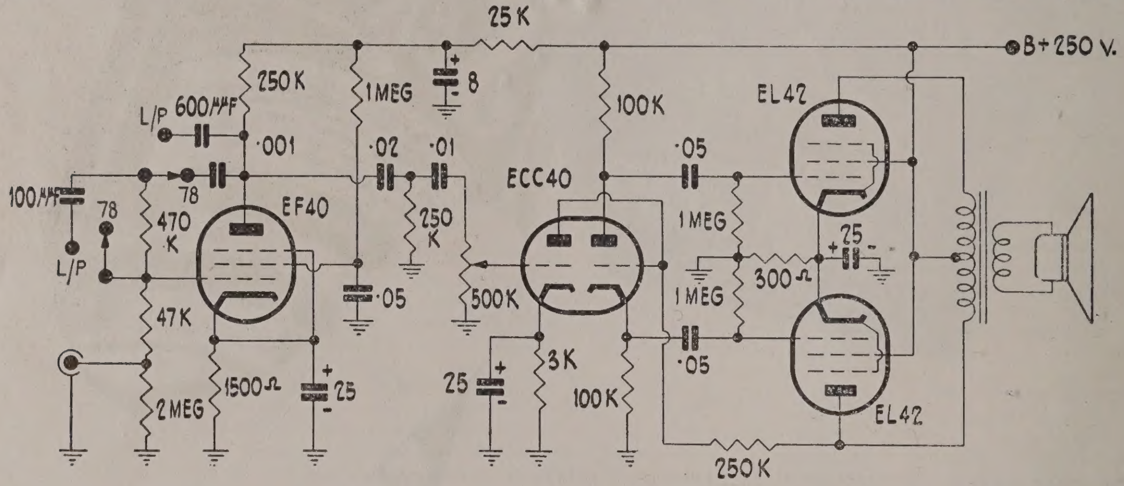
All these advantages are well enough known not to need labouring, but it would do us little harm to stop and consider what marvellous strides the mechanical reproduction of music has made, even in the lifetimes of us who do not yet consider ourselves old! When the basic mechanism of disc recording is examined, and found to be no more than scratching a piece of wax with a sharp point of metal, to produce a wavy groove, the remarkable thing is that the scheme works at all. It is not unreasonable to suppose that most of us have at one time or another been moved to bless the names of Berliner, Edison, and the other pioneers, but we should also be grateful that they lived and worked when they did, and not today. Suppose, for example, that by some means or other, modern applied physics had managed to avoid inventing the gramophone until now. Some modern Edison propounds to his Professor of Physics this method of recording sound. The Professor would undoubtedly go away to his study for several nights, and come up with the answer that it would be impracticable—that no amount of scratching on wax or any other material would enable the whole incredibly complex sound structure of an orchestra to be recorded, let alone reproduced. And there the matter would probably rest. Recording is a bit like the internal combustion engine. Both produce the most excellent results, and yet both methods are just about as "Heath-Robinson" as anything that great cartoonist ever drew.

A Small Amplifier For Portable Radio-Grams

This small amplifier, with an undistorted output of 5 watts, has been designed for those who want a simple circuit, giving good quality, that can be built in a small space, and which has a moderate power supply requirement.

INTRODUCTION

Quite recently, some of the manufacturers of radio sets have placed on the market small, portable radio-gramophones, hardly bigger than the old-fashioned portable gramophone, and no doubt many amateur constructors have been fired with the desire to build for themselves something of a similar kind. With this idea in view, we have designed a small amplifier which, while needing only a small and light power supply, will supply more output, at lower distortion, than the midget commercial radio-grams are likely to give. This should not be interpreted as criticism of these instruments, which, in order to reach a competitive price must use a very simple five-valve circuit. As always, the individual constructor is not limited by the considerations which have a profound effect on the design of commercial equipment. This amplifier itself uses four valves, so that if a radio tuner and rectifier are added, the total will come to at least seven valves. However, even for a portable gramophone, the additional complication is worth while, since it will enable very much better quality to be achieved, at a cost that the average constructor can well afford.



FEATURES OF THE AMPLIFIER

In order to make the most of the five watts that is the greatest output that will not result in too large and heavy a power supply for a portable instrument, two small power valves have been used in push-pull rather than the more usual larger single pentode. The advantages of push-pull are well enough known to need no recapitulation here, and are no less real when applied to a small amplifier as distinct from a large one. Perhaps the best valve available for the purpose is the EL42, which was designed for use in car radios, where economy in power consumption is of considerable importance. As these tubes are Rimlocks, it was decided to use valves from the same series for the remainder of the circuit. Included in the Rimlock range are the EF40, a low-hum, low-noise pentode specially designed for low-level pre-amplification, and a double triode, the ECC40, and both of these fit admirably into the picture. The ECC80 is used as a voltage amplifier and phase inverter, while the EF40 is used as a compensating pre-amplifier, with response curves suitable for playing both 78 R.P.M. and L/P records. It is therefore possible to use either magnetic or crystal pick-ups with the amplifier, which becomes what might be termed universal in application.

Negative feedback is incorporated in a very simple manner that does not subject the builder to the possibility of spurious oscillations at high frequencies, or motor-boating, which is the same thing at low. Of course, since this is the case, the degree of negative feedback is not so high as is found in circuits such as the Williamson, and other super-quality amplifiers, so that the distortion level cannot be expected to be as low as in these circuits. However, a very useful degree of negative feedback is incorporated, and it will be found that the quality of the amplifier itself is far ahead of what can be expected from a small speaker in a not very large baffle; as a result, the performance of the whole is not likely to be limited by the amplifier. Indeed, if one wishes, it would be a very good idea to arrange to feed the output of the amplifier either to the small speaker in the cabinet of the portable gramophone, or to a good 12 in. speaker, adequately baffled. In this case, the amplifier can do duty in place of a large one, for ordinary use, making the portable unit a dual-purpose one. The quality of the amplifier is quite good enough to make this course worth-while, especially if a high-quality pick-up is used.

CIRCUIT DETAILS

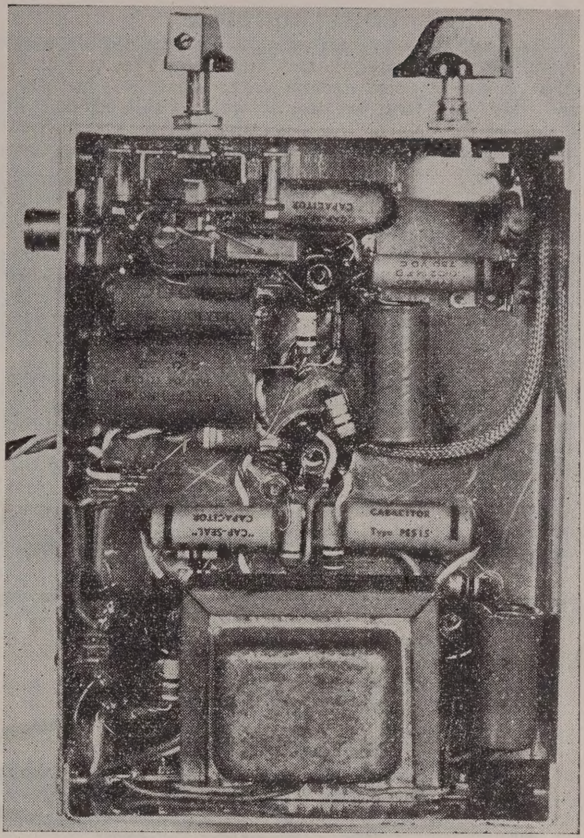
The first valve has a circuit which might almost now be called the "standard R. & E. gramophone pre-amplifier," having been used several times this year already. This time it uses a pentode-connected EF40, with appropriate alterations in circuit values to suit the particular valve type. It has a stage gain of some 20 times, and, as is standard when this circuit is used, the volume

control comes *after* it, instead of in its grid circuit. The switch positions shown give compensation for either 78 or L/P records, and it is an easy matter, should the builder desire, to add a third position giving a flat overall response. This can be done by adding a third position to the switch, and then using it to bring in a 0.05 μf. condenser between the plate of the EF40 and the 470k. feedback resistor. If this is done, the whole amplifier can be used for a radio tuner as well as for records of both kinds. An alternative method of doing this would be to add an extra switch, enabling the tuner to be fed into the volume control, thus bypassing the EF40 altogether on "Radio." The first method will, of course, entail cutting down the output of the radio tuner to a low level, so as not to overload the pre-amplifier stage, but if it is cut down to the point where the volume control gives about the same output on radio as it does from the pick-up, then it is not likely to be overloaded.

Following the pre-amplifier, and between it and the volume control, is a rumble filter. This consists of a double resistance-capacity coupling, and while the values look as if they might cause a good deal of low-frequency loss, in practice they do not, especially when the circuit is used in conjunction with this particular pre-amplifier arrangement. The actual effect is a sharp falling-off in amplification at and below 50 c/sec., so that should a poor motor be used, that induces large voltages in the pick-up at very low frequencies, these will not be passed on to the main amplifier. Should anyone wish to omit the filter, one of the couplings can be omitted altogether, and the other made, say, 0.05 μf. and 0.5 meg.

The second valve, an ECC40, is used as the main voltage amplifier stage, and phase inverter combined. The plate of the former is direct-coupled to the latter, and the bias resistor is so chosen that the phase inverter automatically takes up its correct operating point, with the grid slightly negative with respect to the cathode. This means that the plate of the amplifier section must be at a slightly lower positive potential than the cathode of the second section. With some valves it is necessary with such a direct connection to drop the plate supply voltage for the amplifier section in order to bring the actual plate voltage down low enough, and at the same time use a bias resistor that suits the amplifier section. The first section's cathode resistor in the present circuit must clearly comply with two distinct requirements. It must provide the correct operating bias for the first section, and it must do the same for the phase inverter section, and it is purely a matter of good fortune that it is able to do this!

Negative feedback is applied, but only over the output stage. This gives a very helpful amount of reduction of distortion, without in anyway making the amplifier "touchy," or near the verge of oscillation. While this scheme does not allow one to attain the extremely low figures of distortion achieved by such amplifiers as the "Williamson" and others like it, it does accomplish much, and this sort of amplifier is definitely the best for inexperienced builders to tackle before going on to more advanced circuits that are more difficult to get going properly. While the feedback is applied virtually over the output stage alone, it is actually applied over the phase inverter tube as well. The difficulty about placing feedback over the output stage alone, when the latter is push-pull, is that there are seldom two points which are exactly balanced with respect to each other and to the output stage, to which identical feedback networks can be applied. This is the reason why amplifiers employing a push-pull output stage almost invariably take feedback from one single-ended spot in the amplifier to another, *in front of the push-pull stage.* An example of this is when the feedback is taken from the voice-coil winding of the output transformer to the grid or



Underneath view of the amplifier chassis. The output transformer obscures most of the output valves' sockets. In the centre of the chassis is the ECC40, with the EF40 in front of it. The volume control, selector switch, and input socket can be clearly seen, as can the power lead entering the left-hand side of the chassis. The speaker socket is to the left of the output transformer.

cathode of an amplifier stage ahead of the push-pull stage. Here, the feedback is provided by taking output from one plate of the output stage back to the plate of the voltage amplifier, or the grid of the phase inverter, which in this case is exactly the same thing. At first sight it might appear that only one of the output valves is connected in the feedback network, but that this is not so is easily seen after a little consideration. The feedback voltage is developed across the 250k. resistor, which happens also to be the plate load resistor of the amplifier stage, and is thus applied to the phase inverter grid. In this way, the phase inverter is provided with two signals, one from the pre-amplifier stage, via the amplifier, and the other from the plate of one output tube. Both these voltages go through the rest of the amplifier circuit, so that the upper output tube is provided with feedback voltage in just the same way as is the lower one.

The output transformer matches the speaker to an impedance of 15,000 ohms, and for the purpose, a small 10-watt universal output transformer was used, and was found quite satisfactory. It was mounted underneath the chassis, and can be seen in the underneath photograph.

CONSTRUCTION

The amplifier was built on an aluminium chassis made from 16-gauge material, and measuring 7 in. x 5 in. x 2½ in. It will be noted that no power supply was included, and this was done because it was considered that in designing the cabinet for a portable instrument, such as the amplifier was designed for, more latitude is given if there are two small units to be mounted than one larger one, even if the total chassis area is slightly larger than that of the single unit. In actual practice, it is possible to make the total area of a two-unit affair considerably smaller than that of a single-unit one. This is because there is no need to leave spaces on the amplifier chassis so that the low-level components do not come near the power supply. The waste space is much smaller, and this fact can be taken advantage of in designing a small cabinet.

The output tubes' sockets are almost hidden by the output transformer, and the layout of stages is clearly shown in both the cover photograph of this issue, and the underneath view. Contrary to usual practice, the controls are placed on the short side of the chassis so that the latter is only 5 inches wide, and 7 inches deep. This again is likely to be of assistance to builders of portable instruments. The control on the left is the compensation switch, while the volume control is on the right. The short length of shielded wire takes the output of the volume control to the grid of the ECC40 amplifier section, but the control is near enough to the plate of the EF40 to make it unnecessary to shield the lead to the volume control.

There is a seven-pin valve socket mounted to the left of the output transformer to take the leads from the multi-tapped secondary of the output transformer, so that any speaker can be matched without the necessity for removing the latter from the chassis. The power is brought in through a three-wire cable, and terminated on a tag-strip near the middle of the left side of the chassis, while the input socket is near the front, also on the left side, conveniently situated with respect to the pre-amplifier valve.

Practically all the wiring is done point-to-point, using the valve socket tags as the anchoring points for the small condensers and the resistors. Where these do not terminate on a valve pin, insulated solderings tags are provided as anchor-points, while liberal use is made of earthed solder lugs for making the earth connections. Apart from these few remarks, no special building instructions should be necessary, since if the same chassis size and layout are used, all leads will be found to be quite short.

Two Strobotron Circuits for a Stroboscopic Light Source

Some time ago "Radio and Electronics" published a circuit for a stroboscopic lamp, using as the source of light an ordinary neon bulb. This arrangement worked very well, but suffered from the fact that the light output was not very great. However, if a strobotron tube is used, much more light can be obtained—enough to make the instrument usable under conditions of quite strong ordinary illumination.

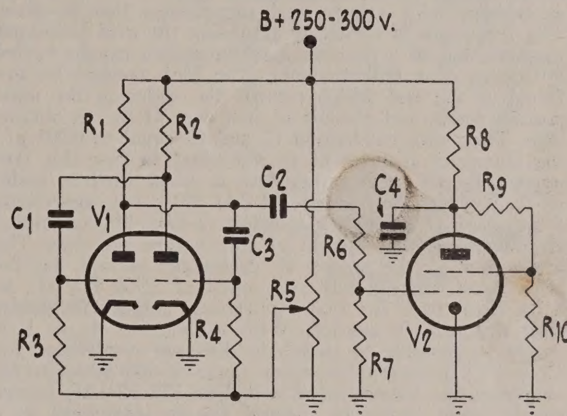
INTRODUCTION

The uses of the stroboscopic light source are well enough known to require very little comment, perhaps the most common use being that of the examination of rotating or reciprocating machinery, and measuring its speed. For those who are not familiar with the operation of such devices, however, a brief explanation of the principle would perhaps be useful. A stroboscopic lamp is simply one which does not shine continuously, but which emits light in very short bursts, the frequency of which can be controlled. If a rotating shaft is examined with such a light, and the frequency of flashing is varied, it is found that at certain frequencies the rotating part under examination appears to be stationary. If the frequency is very slightly removed from one of those which appear to make the object stand still, the shaft will be seen to rotate slowly, in a direction depending on which the lamp is flashing slightly faster or slightly slower than the synchronous speed. In this way, the rotation can be "stopped" while it is still actually going at full speed, and its behaviour examined while it is actually doing its job. For example, the use of the stroboscope can show whether or not the shaft is running dead true. It can also be used to "stop" the motion of something which is vibrating, such as the cone of a loudspeaker, which can be examined while it is excited by an audio tone of the same frequency as that of the lamp. Indeed any motion which is periodic and regular can be stopped, or slowed down until the apparent speed is one or two cycles a second, so that the motion can be observed just as if it were actually taking place at that speed.

The stroboscope has relatively few applications to electronic equipment, but is itself an electronic device, and as such can lay claim to a mention in these pages. Indeed, a friend of the writer's who has much to do with the operation of model engines provided himself with a strobotron tube, and asked us if we would work out a circuit in which he could use it for measuring the speed of his motors. It should be obvious that if the frequency control, which determines the flashing rate of the lamp is calibrated in terms of frequency, these frequencies can be translated in terms of R.P.M., since 1 cycle per second is the same thing as 60 R.P.M., and so on. Better still, the control can be directly calibrated in R.P.M. Needless to say, the great advantage of the stroboscope as a revolution counter is that it places no load on the device being measured. This enables accurate measurements to be made of the speed of very low-powered rotating parts, which would be stopped altogether by an ordinary tachometer, or which are too small for one to be attached to them anyway.

A SIMPLE CIRCUIT FOR A STROBOTRON

The strobotron tube itself is a neon tetrode, with a cold cathode, requiring no heating power therefor, an anode, and two control grids, one of which is used much after the style of the screen grid of an ordinary tetrode or pentode, and the other is used as a triggering device, setting off the tube and initiating the flash. The American tube was originally developed by the General Radio Co., of instrument fame, and bears the type number 631-P1. This tube, of course, is not available in this country, but a British made equivalent is, and indeed has been advertised in these pages. This tube has the



COMPONENT LIST

Fig. 1.

R_1, R_2, R_6, 50k.
R_3, R_4, 3 meg.
R_5, 250k. pot.
R_7, R_{10}, 100k.
R_8, 3k.
R_9, 1 meg.
C_1, C_3, see text.
C_2, 0.001 μf.
C_4, 1 μf.
V_1, 6SN7.
V_2, Strobotron, 631-P1 or NSP1.

type number NSP1, and both of them have an ordinary American UX, or four-pin base, and identical connections. They are thus seen to be plug-in equivalents. This price is not low, as is usually the case for special tubes of this nature, but the simple circuit to be described here can be built from scratch, and still leave a little change out of a ten-pound note, so that for anyone who has a requirement for a stroboscope, the total cost need not be high. The more elaborate circuit described later in this article would cost rather more than this, but it has been designed especially with a view to accurate speed measurement, and, as ever, accuracy costs money whatever the measurement being undertaken.

We would like to point out that the two circuits represent different approaches to the problem. The simple cir-

cuit was designed to be inexpensive to build, and to give reasonably accurate speed measurement. It is, however, primarily an instrument for observation purposes, and in any case where visual observation is more important than very accurate measurement of speed, this is the one to build. On the other hand, there is often a need for speed measurements to be made as accurately as possible, and this is the idea behind the more complicated circuit. As far as the flash tube itself is concerned, there is no difference between the performance of the two arrangements. The brilliance of the light is the same for both, as is the duration of the flashes. What counts in speed measurements is the accuracy with which the frequency of the flashes can be controlled and held. The additional circuitry to be found in the second arrangement is solely concerned with the stability of the flashing frequency.

The circuit of Fig. 1 consists of a multivibrator type of oscillator, whose frequency may be varied over a fairly wide range. The valve is a 6SN7, but in practice, any medium-mu double triode could be used without alteration to the circuit values. It would even be possible to use a pair of separate triodes, or pentodes connected as triodes, with screens and suppressors tied to plate. The frequency is varied by returning the grid leaks, not to earth, but to a positive potential which can be varied by means of a potentiometer. The high frequencies are found at the end which returns the slider to the most positive point, and a range of just over 4½ to 1 is obtainable. Thus with condensers C_1 and C_2 equal to 0.001 μf., the frequency is from 65 to 300 c/sec. In case this frequency should seem rather low to those used to audio work, it should be pointed out that 300 c/sec., represents a speed of 18,000 R.P.M., and it is only in exceptional circumstances that speeds of this nature are met. The lower end of the range, 65 cycles per second, on the other hand, corresponds to a speed of 3,900 R.P.M., so it is clear that for many purposes, frequencies lower than this will be needed. With a range of 4½ to 1, it would be possible to switch in different condensers for C_1 and C_2 to give a frequency range of 14½ cycles to 65, and here, the lowest speed would be 870 R.P.M. Lower speeds could easily be catered for by switching in a third range, giving, say, 3½ cycles to 15. Three ranges organized in this way would give speeds from 210 R.P.M. to 18,000, which would cover most contingencies. The switching is not shown on the diagram, but would be very simple to add. A wafer switch could be used, giving two poles, three positions. The three condensers at each of the multivibrator plates can all be connected to the plate pin, with only the grid ends switched. There is no necessity to switch both ends of each condenser. The output of the multivibrator is fed to the control grid of the strobotron through a 0.001 μf. condenser. The size of this condenser is important, and should not be altered, for the proper triggering of the strobotron depends largely on this being correct. The 0.001 μf. condenser, together with the 150k. to earth, forms a differentiating circuit, so that instead of the square-wave at the multivibrator plate being directly applied to the grid of the strobotron, a series of narrow pulses, alternately negative and positive, is found there. The negative pips are the ones that do the triggering, while the positive ones have no effect, unless they are too great in amplitude. Should this be the case, the strobotron will be triggered twice in every cycle of the multivibrator waveform. This does not matter as far as using the light for observation purposes is concerned, but if measurements are to be made, it will result in a reading that is twice as high as the real figure. However, the circuit has provision to prevent this from happening. Luckily, the positive pulses will not trigger the tube so easily as the negative ones, so that if the latter are made only just large enough to trigger it, there is little or no possibility of the unwanted triggering taking place. For this reason, we have placed a voltage divider at the grid of the strobotron tube, consisting of a 50k. and a 100k. resistor.

The circuit of the strobotron itself calls for a little comment. From the H.T. line there is a 3,000-ohm resistor, with a 1 μf. condenser to earth. The anode of the strobotron is connected to the condenser, the purpose of which is to supply the energy for each flash of the tube. In between flashes, it charges rapidly through the 3k. resistor, and it is its rapid discharge through the strobotron that gives the flash in which we are interested. It might be asked why the anode of the tube is not connected straight to the H.T. line. Well, if it were, the tube, once triggered, would stay permanently struck, and would not go out, as it must before it can be triggered again. The size of the condenser determines how much energy is dissipated by the tube at each flash, so that if the tube is not to be over-run, there is an upper limit to the size of the condenser, assuming that the H.T. voltage is fixed. For a 300-volt supply, the maximum size is 1 μf., and this is used, because it gives the brightest flash. The tube is allowed a maximum D.C. current through it of 50 ma., and it will be found that with the H.T. at 300 volts, and at the maximum frequency, the 1 μf. condenser will just allow the current through the tube to reach 50 ma. If for any reason very high speeds are not required, the frequency range of the oscillator can be limited to, say, 200 c/sec., or a maximum speed of 12,00 R.P.M. This will allow the condenser to be raised by a factor of 300/200, making it 1.5 μf., and resulting in a current of 50 ma. at the new top frequency. Of course the practical advantage of such a procedure is that the brightness of each flash will be increased in proportion to the size of the condenser. If the upper frequency limit can be still further lowered, the condenser can be correspondingly increased, giving still greater brilliance. It will be seen that the strobotron is rather like the flash-tubes used for photography, in that both of them derive their energy from the discharge of a charged condenser. The only difference, basically, is that the one is a much smaller-rated device, which can work at relatively high frequencies, whereas the other can only be flashed intermittently, at a rate of about one flash every six seconds. Of course, by making the single flash tube keep to a very slow repetition rate, it is enabled to handle very much larger energies at each flash. The average flash tube can dissipate 100 joules, while the strobotron is limited to a dissipation of 0.045 joules at its highest flashing frequency.

The screen grid of the strobotron tube is fed from a voltage divider, placed across the charged condenser, and NOT straight across the H.T. line. The purpose of this is to prevent a discharge taking place between the screen and the anode, immediately the anode circuit has flashed, and while there is a potential difference equal to the H.8. voltage, between the anode and the screen. By feeding the latter from the condenser, the screen voltage rises and falls with the anode voltage, so that a high difference of potential never exists between anode and screen.

Those wishing to try the circuit of Fig. 1 will find it very amenable, and easy to get going.

A MORE AMBITIOUS CIRCUIT

One of the disadvantages of the simple multivibrator for triggering a stroboscopic lamp is that its frequency stability is quite poor. If variations in line voltage occur, they will result in quite serious variations in fre-

quency, and therefore in speed readings should they be attempted. Suppose we want to measure speeds of the order of 15,000 R.P.M., to an accuracy of, say, 500 R.P.M. This does not sound like very high accuracy, but it does mean that our instrument must be accurate to within better than 3½ per cent., and if we require our readings to be accurate to within 100 R.P.M., the frequency accuracy of whatever oscillator is used must be held within 0.7 per cent. Of course, oscillators can be made very much more stable than this, but only by densers, as in the Fig. 1 circuit, and would give excellent overlap between ranges, and an overall range of 900 to 18,000 R.P.M. The oscillator circuit is provided with a regulated H.T. supply by means of the VR150, thereby adding to the excellent inherent frequency stability of the circuit. The values have been chosen so that the oscillator is not "working hard," and is therefore producing an output that is not far removed from a good sine-wave in shape. Under these conditions, the stability is better than if it were allowed to oscillate harder, and

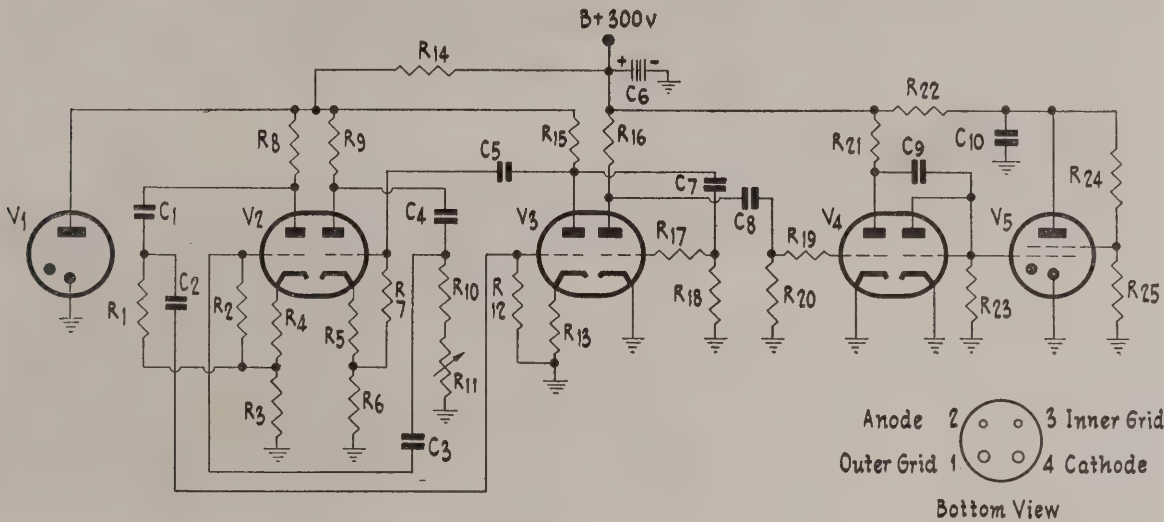


Fig. 2.

COMPONENT LIST

R_1, R_{24}, 50k.
R_2, R_7, R_{12}, 3 meg.
R_3, R_6, R_8, R_9, R_{10}, R_{15}, 5k.
R_4, R_5, 1k.
R_{11}, 500k. pot.
R_{13}, 800 ohms.
R_{14}, R_{22}, 3k.
R_{16}, R_{22}, 100k.
R_{17}, R_{19}, R_{23}, 1 meg.
R_{18}, R_{20}, 2 meg.
R_{25}, 15k.
C_1, C_4, see text.
C_2, C_3, C_5, C_7, C_8, 0.05 μf.
C_6, 16 μf. 450v. electro.
C_9, 0.001 μf.
C_{10}, 1 μf.
V_1, VR150.
V_2, V_3, V_4, ECC34.
V_5, Strobotron, 631-P1 or NSP1

extensive and costly means, so that it is easily seen that the price of very high accuracy is quite large. However, the circuit of Fig. 2 should hold its frequency within 1 per cent., and this will give an accuracy of 100 R.P.M. at 10,000 R.P.M., which is relatively good, and quite high enough for all but the most refined purposes.

The most essential feature of the Fig. 2 circuit is a very stable oscillator circuit. This circuit has been described before in these pages, under the title of "A New Phase-shift Oscillator Circuit," in the April, 1952, issue. This circuit is notable for the fact that a reasonably wide frequency range can be covered with it, when only a single resistor is made variable. Most R-C oscillators require at least two resistors or condensers to be ganged in order to provide a wide enough range on each step of the switched elements. The first valve V_1, and the left-hand section of V_2 make up the oscillator circuit, in which the single 500k. variable resistor controls the frequency over a range of almost 10 to 1. With condensers of 0.025 μf. in circuit for C_3 and C_4, the range was 35 to 300 c/sec., while 0.05 μf. condensers were found to give a range of 15 to 150 c/sec. These two ranges could be incorporated by switching the con-

to produce something like a square-wave at the output. The right-hand section of V_2 is simply an amplifier stage, producing a clipped version of the input signal. This valve's output is applied to the left-hand section of V_3, which is a squaring stage, and produces an output of nicely rectangular shape, with very rapidly rising leading and trailing edges. All this circuitry provides us with virtually the same waveform as does the multivibrator in Fig. 1, but with vastly improved frequency stability. The output of the squarer is applied to the triggering grid of the strobotron, via a differentiating circuit comprising a 0.001 μf. condenser and a 1 meg. resistor. The second half of V_3 is connected as a diode, with grid and plate tied together, and is used as a clipper. The differentiating circuit's output consists of a series of alternate positive and negative pulses, there being one positive and one negative pulse for each cycle of the original sine-wave. It will be remembered that in the simple circuit, we had to take steps to prevent the positive pulses from triggering the strobotron as well as the negative ones, and in the case of Fig. 1 this was achieved by making the amplitude of the pulses just

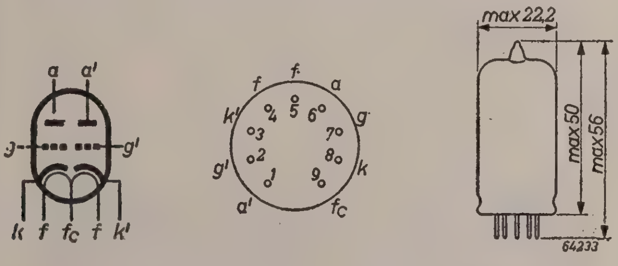
(Continued on Page 33.)

TUBE DATA: The R.F. Double Triode ECC81

DESCRIPTION

The ECC81 is a double triode on Noval base, intended primarily for use as oscillator-mixer and as R.F. amplifier in television receivers. A centre-tapped heater is employed, giving alternative ratings of 6.3 V., 0.3 A and 12.6 V, 0.15 A.

The higher performance of a triode compared with a pentode in the frequency range from 100 mc/sec. to 300 mc/sec. is well known and the provision of two high-quality triodes with separate cathodes in a single envelope ensures maximum circuit economy and flexibility. This double triode is suitable for all the radio-frequency stages in a receiver, i.e., R.F. amplifiers, mixers, and local oscillators.



Dimensions and under-socket connections.

The electrical characteristics of the tube have been designed to meet the combined requirements of an efficient amplifier and a general-purpose radio-frequency triode. The interelectrode capacitances have therefore been kept low and the slope and the amplification factor fairly high.

APPLICATION

1. The ECC81 as R.F. Amplifier

In the 100 mc/sec. to 300 mc/sec. frequency bands the noise level due to static and cosmic noise is very low, but full advantage of these favourable conditions can only be gained when the receiver noise level is reduced to a minimum. This can be done by using triodes in the R.F. amplifier and mixer stages.

A triode can be connected in three ways—grounded grid, grounded cathode, and grounded anode. The theoretical noise factors for the three circuits are very similar but the terminal impedances are different and in practice it has been found that the grounded-grid and grounded-cathode circuits give the best results.

The grounded-grid circuit has been widely used as a single-stage amplifier, since the grid forms an effective screen between input and output circuits and reduces regenerative feedback to a tolerable level.

A single grounded-cathode stage can be used but neutralization of the feedback impedance between anode and grid is difficult, especially when the circuit has to operate over a range of frequencies. However, when the grounded-cathode stage is followed by a grounded-grid amplifier the voltage gain of the first stage is approximately unity and neutralization can be accomplished in a simple way. This cascade combination of two triodes has an overall stability and voltage gain as good as those of an equivalent pentode but with the lower noise factor of a triode. Using an ECC81, this circuit can be constructed with one tube.

In some receivers it may be advantageous to use a balanced push-pull circuit and then again the ECC81 is eminently suitable. The receiver designer is therefore able to choose any one of a number of circuits according to individual requirements.

Grounded grid

A typical grounded-grid circuit is shown in Fig. 1. This circuit is essentially a feedback amplifier, as the output current flows through the input circuit. The input impedance due to feedback is $(R_i + R_a)/(\mu + 1)$, where R_a is the resonant anode load resistance. For values of R_a which are small compared with R_i, this expression reduces to $1/S$, which is about 200Ω for the ECC81. The input impedance is therefore very low and the voltage gain in the aerial circuit L_1 is small, but on the other hand the bandwidth is very large and over a very wide range of frequencies no tuning is necessary. The cathode coil L can be used to match directly to an unbalanced feeder by means of a suitable tap, or it may be replaced by a balance-to-unbalance transformer to match a balanced feeder.

An auto-transformer may be used for the output coupling but at the higher frequencies a π-filter is more convenient. The input capacitance of this filter C_3 is the output capacitance of the tube. The capacitance C_5 is adjusted to give impedance matching to the subsequent stage and C_4 is the tuning capacitor. The input impedance of the filter is approximately $(C_5/C_3)\ R_{in}$, where R_{in} is the input impedance of the next stage, and this has to be matched to the output impedance of the tube for optimum power transfer. This output impedance is $R_i + \mu R_g$, where R_g is the total effective dynamic resistance in the grid circuit. R_1, C_2, and L_2 are the bias components and the choke for the anode supply.

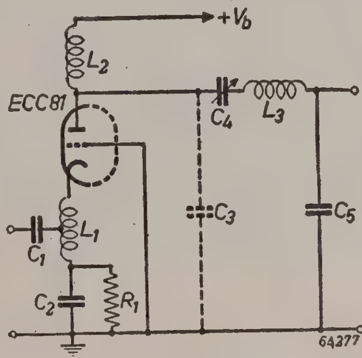


Fig. 1.—Ine section of the ECC81 as a grounded-grid amplifier.

Typical figures for the performance of an ECC81 in this circuit at a frequency of 200 mc/sec. are: gain 12 db. and noise factor 7.5 at a bandwidth of 6 mc/sec. In a practical circuit arrangement the two halves of the ECC81 may be used separately for different frequency bands or, alternatively, may be connected in parallel as a single triode with double the slope and half the anode impedance.

Grounded cathode

In contrast with a pentode a single grounded-cathode triode amplifier is not suitable as a radio-frequency

amplifier in a receiver since the necessary neutralization of the anode-grid feedback capacitance is difficult to maintain, especially over a wide range of frequencies. Without neutralization stability can be achieved by employing a very low voltage gain, with a resultant loss in voltage sensitivity and an increase in noise level due to the second amplifier or mixer.

These disadvantages can be eliminated by using a cascade combination of two triodes, i.e., the two sections of an ECC81. A non-critical neutralizing circuit can then be used purely to obtain the minimum noise factor and

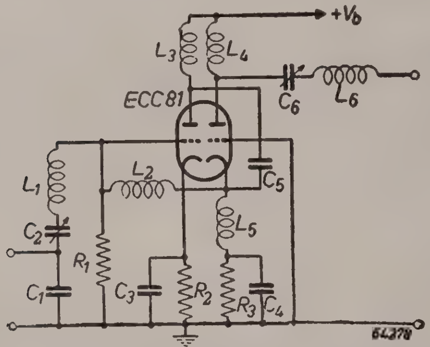


Fig. 2.—Cascade combination of the two triodes of the ECC81. One section is operating as a grounded-cathode and the other as a grounded-grid amplifier.

without affecting the stability. A typical circuit is shown in Fig. 2. In this circuit L_2 is the coil for compensating the anode-grid capacitance of the first triode. Either L_3 or L_5 may be tuned to the signal frequency, L_4 and L_3 or L_5 being R.F. chokes.

The anode of the grounded-cathode triode is coupled to the cathode of the second triode, which is a grounded-grid amplifier. The input impedance of the grounded-grid stage is approximately 1/S, so that the voltage gain of the first triode is unity. The output current of the first stage flows through the cathode circuit of the second stage, with the result that the overall gain of the system is SR_a, i.e., that of a pentode with equivalent mutual conductance. The combined circuit is stable, the overall gain is high, and owing to the power gain of the first stage and the negative feedback of the grounded-grid amplifier the noise factor is that of the first triode.

Typical performance figures for the circuit of the type illustrated at a frequency of 200 mc/sec. are: gain 13 db. and noise factor 6.5 at a bandwidth of 11.5 mc/sec.

This cascade combination of the ECC81 is very suitable for use in a tuner in conjunction with another ECC81 operating as mixer and local oscillator. For some television applications it may be necessary to provide two distinct frequency bands with switched channels in each band. Channel selection can be accomplished by tuning all the R.F. amplifier and oscillator circuits, but the relatively complex tuning mechanism tends to lower the performance of the receiver compared with a fixed-tuned circuit. An alternative is to use a high intermediate frequency and to increase the bandwidth of the R.F. amplifier circuits, so that channel selection can be achieved by tuning the local oscillator only. The image frequency is thereby placed outside the television bands and, although the performance of the wide-band circuits is not so good, the deterioration due to the necessity for tuning is eliminated. Owing to its high input impedance the EF80 pentode is very suitable as a high-frequency I.F. amplifier. The reduced gain to be obtained with a wide-band R.F. amplifier increases the contribution of the mixer to the total noise and a triode mixer is therefore essential.

Push-pull amplifier

A push-pull amplifier may be conveniently constructed around an ECC 81. This circuit has a high L-to-C ratio, high gain and low noise factor. A typical circuit for operation at 200 mc/sec. is shown in Fig. 3.

A balanced input transformer L_1L_2 couples the balanced feeder to the control grids, and neutralizing capacitors (C_2, C_3) of the order of 1 pF are cross-connected between

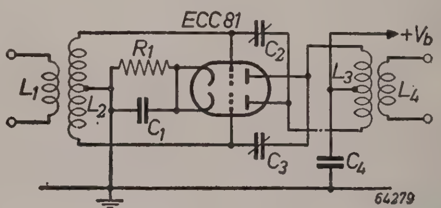


Fig. 3.—The ECC81 as a push-pull R.F. amplifier.

the respective anodes and grids. The output may be unbalanced and fed into a single-ended mixer and local oscillator, or balanced and fed into a push-pull mixer with push-pull local oscillator using two additional ECC81 tubes. Typical performance figures for this R.F. amplifier are: gain 21 db., bandwidth 2.5 mc/sec., noise factor 5.

2. The ECC81 as Frequency Changer

As a frequency changer in high-frequency receivers the ECC81 possesses two distinct advantages: the separate mixer and oscillator sections are contained in a single envelope, and the noise level of a triode mixer is sufficiently low to allow its use with a relatively low-gain, wide-band R.F. amplifier.

A typical frequency changer circuit with the ECC81 is shown in Fig. 4. The oscillator voltage for the mixer is derived from a small capacitor of the order of 1–2 pF

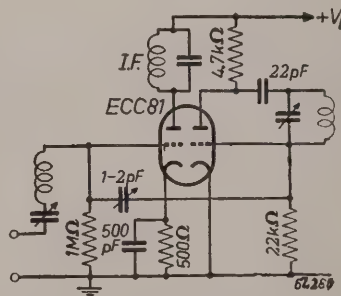


Fig. 4.—The ECC81 as a frequency changer.

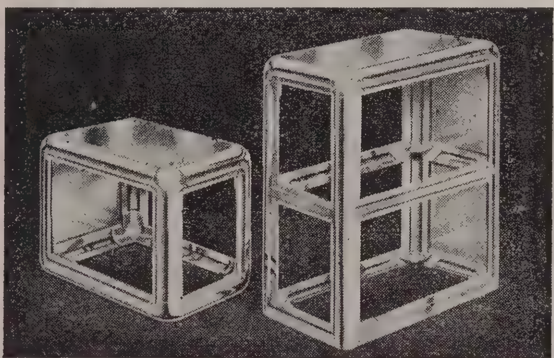
connected directly between the oscillator circuit and the mixer grid. This capacitor should be adjusted until the optimum oscillator drive is obtained. The oscillator voltage at the mixer grid should be 2–2.5 V according to the anode voltage used, and the drive should be adjusted so that when tuning over a frequency range its minimum value is equal to the optimum value. This is necessary

(Continued on Page 35.)

WIDNEY DORLEC CABINET SYSTEM AND FITTINGS

The Widney Dorlec Cabinet system consists essentially of a series of pre-fabricated die cast corners, extruded sections and various other formed components which can be readily assembled to enable modern fully radiused cabinets and racks to be built without special tools.

The frame-works illustrated use die cast corners connected by specially shaped extruded sections cut to the required lengths. Special brackets can be fitted to enable slide rails to be used and the whole framework can either be screwed or riveted together and panels either of plastic or metal, as desired, can be fitted by means of chrome-plated screws. In addition to the rectangular form, cabinets can also be built with 45-degree sloping fronts



Typical assemblies of the Widney Dorlec Cabinet System.

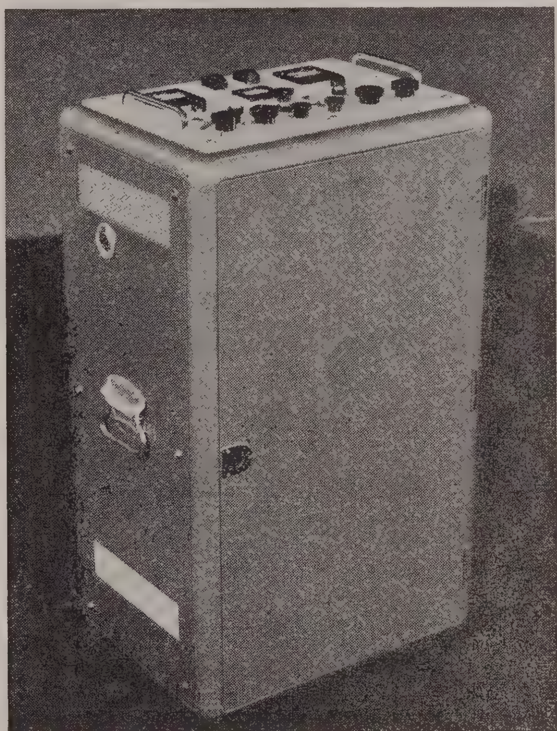
and hardware in the form of handles, hinges, gripper catches and combined barrel lock and handles can be provided. Where the requirements call for the use of drawers, telescopic runners can be provided, either steel or non-magnetic, and up to 30 in. in length and suitable for loads up to 250 lb.

The standard gauge for the corners and sections is designed with a radius of 1 $^3/_{16}$ in. but a smaller gauge based on a radius of $^{13}/_{16}$ in. is also available.

Cutting and drilling jigs which act as guides for hacksaw blades and also provide the necessary facilities for drilling correctly located holes in the sections, are available thus providing means whereby cabinets can be fabricated without special tools. All sections and corners are made of aluminium but sections can be obtained in high tensile duralium to special order.

Most of the major manufacturers of electronic equipment in the United Kingdom are users of these cabinets.

The first user in New Zealand is the National Film Unit, whose engineers have recently completed a



Transportable dual amplifier built by National Film Unit, using Widney Dorlec Cabinet System.

transportable dual amplifier which is being used with a special 16 millimeter projector for the screening of their recently completed colour picture entitled "New Zealand in Colour." An illustration of the amplifier as built by the Unit is shown above.

This unique cabinet assembly system is manufactured in England by Messrs. Hallam, Sleigh and Cheston Limited, represented in New Zealand by

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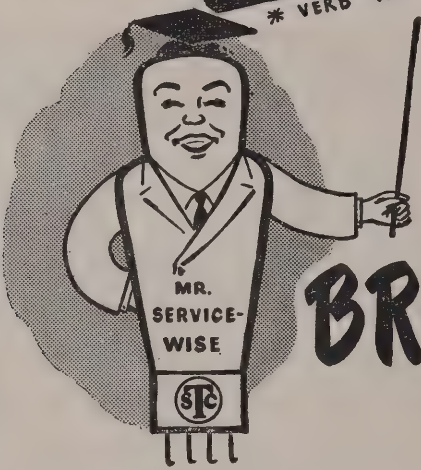

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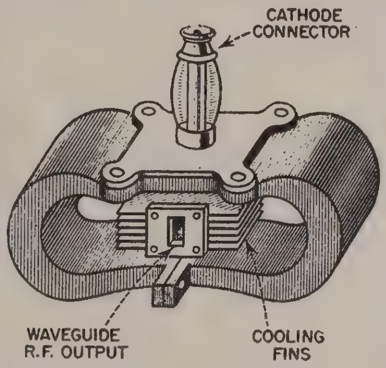
Introduction to Radar Techniques

Part II.—The Magnetron Transmitting Tube

By the Engineering Department, Aerovox Corporation

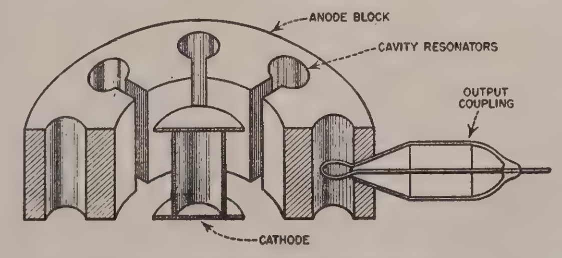
The previous issue discussed the functioning of the generalized radar set and enumerated the factors which determine its performance. Succeeding issues will deal with the special components of a typical microwave radar system. The present article describes the magnetron transmitting tube which is almost universally used as the high power R.F. generator in modern radar practice. A simplified theory of its operation will be developed and some practical aspects of magnetron design and operation will be discussed.



TYPICAL RADAR MAGNETRON

FIG.1

The magnetron tube is remarkably well suited to fulfilling the requirements of the pulsed radar system for short pulses of very intense R.F. energy at very high frequencies. It is probable that no other electronic development contributed as substantially to making microwave radar possible and practical. As a consequence, the magnetron has emerged since 1940 from the status of a laboratory curiosity to a highly developed vacuum tube category having dozens of standardized types. Pulsed

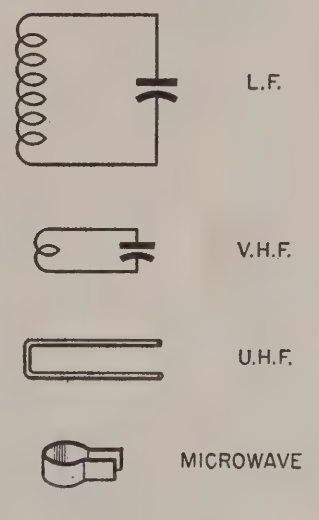


INTERNAL STRUCTURE OF MAGNETRON

FIG. 2

power outputs range from a few watts to several million watts at frequencies extending from a few hundred megacycles to well over 30,000 megacycles. Operating efficiencies as high at 85 per cent. at 12000 megacycles have been reported by reliable observers. The physical appearance of a typical magnetron tube is illustrated in Fig. 1.

A magnetron is a diode electron tube in which a strong magnetic field is used perpendicular to the direction of electron flow. It is capable of generating extremely high frequencies at good efficiency because the frequency-limiting effects of electron transit time, which limit conventional negative-grid triodes to about 3000 megacycles, are reduced by the action of the magnetic field.



EVOLUTION OF CAVITY RESONATOR

FIG. 3

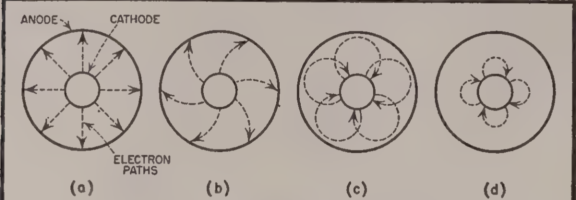
A further advantage is gained from the fact that the resonant circuits are usually contained within the vacuum envelope of the tube, thus reducing lead inductance.

Fig. 2 shows the internal structure of a microwave magnetron. A cylindrical cathode is mounted in the centre of a solid copper anode bearing a number of resonant circuits machined in its inner surface. Each of these "cavities" is the equivalent of a parallel resonant circuit tuned to the desired magnetron operating frequency The evolution of such microwave resonant circuits from the conventional parallel L-C circuit is demonstrated in Fig. 3. An external circuit may be coupled to these resonators by an inductance loop as in the low-frequency case. The entire assembly is enclosed in a vacuum-tight metal envelope and evacuated. A magnet, which may or may not be an integral part of the magnetron, is used to apply a magnetic field in a direction parallel to the cathode.

THEORY OF OPERATION

In any oscillator or amplifier tube the electrons possess energy of motion, or *kinetic energy*, which was gained from the applied D.C. voltage. This kinetic energy

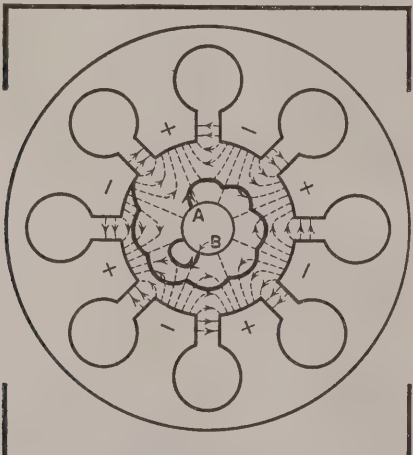
is converted to useful radio frequency energy when these electrons travel against a retarding R.F. field so that their velocity is reduced. In a triode, R.F. energy is added to the "tank" circuit by electrons which flow between the grid and the plate while the latter is at the negative part of the R.F. cycle. Electrons which are not decelerated by the retarding R.F. field dissipate their kinetic energy in the form of heat upon striking the anode. If all of the electrons could be slowed by the retarding R.F. field to zero velocity before reaching the anode, all of the energy gained from the D.C. field would be converted to R.F. energy, and the efficiency of the tube would be



ACTION OF MAGNETIC FIELD IN DIODE
(Field Perpendicular to Paper)
FIG. 4

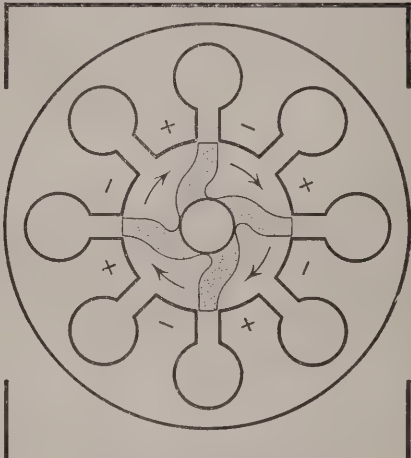
100 per cent. Such is far from the actual case, however. Triodes are severely limited at high frequencies because, for maximum energy conversion, the electrons must traverse the space between the grid and plate while the retarding field there is maximum. This dictates that the *transit time* should be less than about one-tenth of the period of one R.F. cycle for good efficiency. Electrons which are not so optimally phased do not interact with a strong retarding field and so are wasted. In going between the cathode and plate, the electrons in a triode have only one chance to interact with the R.F. field.

In the magnetron, the mechanism of energy conversion is much more perfect, however. Electrons may take the period of many R.F. cycles to reach the anode and may



PATHS OF ELECTRONS IN MAGNETRON
FIG. 5

interact with a strong retarding field almost continuously during this time. How this can occur is illustrated in Figs. 4 and 5. In the absence of a magnetic field, the electrons in a magnetron would flow radially from cathode to anode as in any diode. See Fig. 4a. However, when a slight magnetic field is applied parallel to the axis of the cathode, the paths of these electrons are bent as in Fig. 4b. As the magnetic field strength is increased, a critical value is reached at which electrons no longer reach the anode, but describe a loop, or *orbit,* and return to the vicinity of the cathode. This is the condition called "cut-off," since no current reaches the anode. (Fig. 4a.) If the magnetic field is increased further, the electrons orbits become very small as in Fig. 4d. Theoretically, the electrons return to the surface of the cathode with zero residual energy in a non-oscillating magnetron such as we have been discussing. This is because the electrons lose as much energy returning to the cathode against the D.C. field as was gained from it during the outward travel.



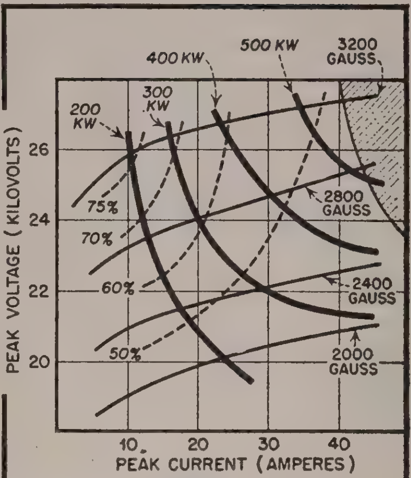
ROTATING SPACE CHARGE IN MAGNETRON
FIG. 6

The above considerations are true of a *static,* non-oscillating, magnetron. When R.F. oscillations, such as might be started by noise voltages or other transients, are present in the cavity resonators, these conditions are greatly modified. The R.F. voltages associated with these oscillations produce fringing electric fields in the *interaction space* between the cathode and anode which extract energy from the whirling electrons in a truly remarkable manner.

Fig. 5 shows the instantaneous distribution of these fields within the magnetron interaction space. The arrows indicate the direction of the force which the fields exert on an electron. The electric fields vary sinusoidally with time, so that one-half cycle later the arrows are reversed. It will be noticed that retarding fields exist across each alternate gap. An electron starting from point "A" travels against the R.F. field during its first orbit, and so delivers energy to the resonant circuit. Having delivered part of its kinetic energy, it no longer can return to the cathode surface but comes to rest some distance from it. It is then re-accelerated by the D.C. field and, since the fringing R.F. field has reversed in the meantime, passes the next resonator gap against the R.F. field. This process continues with the electron progressing closer to the anode with each orbit and converting part of its kinetic energy to R.F. energy each time it passes a gap. Thus, an in-phase electron has many chances to deliver energy to the oscillating circuit and reaches the anode surface with little residual energy to be converted into heat.

Conversely, consider an electron emitted at point "B" in Fig. 5. Here the fringing field is such as to accelerate the electron. Since the R.F. field does work on the electron, energy is subtracted from the useful output of the tube and its efficiency is reduced. However, such out-of-phase electrons are eliminated from the interaction space after only one orbit since, in gaining energy from the oscillating circuit, they have more than enough energy to reach the cathode on the return trip. The result is that these electrons bombard the cathode and dissipate their residual energy as heat. This gives rise to two effects which are unique characteristics of magnetrons. One effect is that the returning, or *back-bombarding,* electrons dislodge other electrons from the surface of the cathode. This *secondary emission* greatly enhances the current normally available from the cathode, making higher power possible. The other effect is that the bombarding electrons sometimes dissipate enough heat at the surface of the cathode to permit the normal cathode heating power to be disconnected without interrupting operation. Thus, in the magnetron, even the otherwise wasted electrons are utilized to improve the overall efficiency of the tube.

Of course, the above discussion assumes that the electrons which are delivering energy rotate around the cathode at a velocity which will keep them in step with the alternating R.F. field. This *synchronous* velocity is achieved by adjusting the operating voltage E for a given magnetic field B, since the rotational velocity of the electrons is equal to E/B. Thus, the electrons in a magnetron which are phased so as to deliver energy to the resonators remain in the interaction space during many R.F. cycles while the out-of-phase ones are eliminated after one orbit. The net effect of this *electron sorting* is to built up a whirling space charge pattern having the general shape shown in Fig. 6. Since most of the electrons are in the regions of retarding R.F. fields at any instant this pattern has half as many "spokes" as there are resonators in the anode.



TYPICAL MAGNETRON PERFORMANCE PLOT

FIG. 7

(Continued on Page 48.)

Note on Measuring Radio Frequencies Outside the Range of a Signal Generator

The short article hereunder will, we hope, be found useful by many of those who work with radio frequencies without the blessings of unlimited test equipment. If its limitations are realized, it can give results as accurate as the calibration of the signal generator that is used to make the measurements.

It often happens that when measurements of frequency are to be made, there is not a signal generator available which is calibrated over the required range, and this makes it rather a problem to obtain any sort of a measurement. However, as long as the frequency is not too much higher than the highest frequency of a signal generator that is available, the following method will give results which are as accurate as the signal generator itself. The only other equipment required is an absorption wavemeter, and depending upon circumstances, even this can be dispensed with. The method about to be described applies equally well to measuring the tuned frequency of a transmitter, oscillator, or receiver, and so is very versatile. The usefulness of the ordniary signal generator, calibrated up to 20 or 30 mc/sec. is therefore greatly extended, and the method has been consistently used for some time in the *Radio and Electronics* laboratory.

A PRACTICAL EXAMPLE

Let us suppose we have built a receiver for the 50 to 54 mc/sec. amateur band. For the sake of argument, it is a super-regenerative set, and we want to put it on frequency, but do not have a signal generator which covers the band. We have, however, a generator which goes to 30 mc/sec., and want to use its harmonics. The receiver is very sensitive, being a super-regenerative, and has no image responses to cause confusion. We do not know whether it is anywhere near the required band, because a very slight difference in the tuned circuit could put it some megacycles away. Thus, we turn on the signal generator, and find that at four or five settings on the highest band covered by it, we get quite strong responses in the receiver. The problem is to find out which harmonic the receiver is actually on, so that its frequency can be measured by taking the dial reading of the signal generator at one of the response points, and multiplying by 2, 3, or 4, according to the harmonic we find to be the right one. In order to find the right harmonic, all we do is as follows. We read the frequencies of two adjacent spots on the signal generator's dial, which give responses in the receiver. If the higher of these frequencies is called F_2 and the lower is called F_1, then the harmonic number is given by the equation:

$$n = \frac{F_1}{F_2 - F_1}$$

This is the number by which F_2 must be multiplied in order to give the frequency of the receiver. It is important to note that the *higher* of the two frequencies is the one that is multiplied by the whole number so obtained in order to get the answer.

Now when this is done, it will certainly happen that the answer for n comes out to something like 2.1 or 3.9. It is obvious that there is no such thing as the 2.1th harmonic of any frequency, so that the measurement indicates that the correct number is 2, or, in the second example, 4. The fact that the answer does not come out accurately to a whole number is attributable simply to the fact that the frequencies are not known with absolute accuracy. If they were, the answer *would* come out to an exact whole number.

Needless to say, the method must be used with a certain amount of discretion if it is to give a correct answer. However, the result of working out the formula for n will usually tell us whether the measurement is of any use or not, because if the answer is anywhere in the vicinity of 2.5, 3.5, etc., it is impossible to tell whether the correct figure for n is 2 or 3, in the first example, or 3 or 4 in the second.

Taking the original example of the 50–54 mc/sec. receiver, suppose we find that according to the calibration on the signal generator the receiver responds at 26.9 and 18.1 mc/sec. We therefore have that $F_1 = 18.1$, and $F_2 = 26.9$ mc/sec. Using the formula, we get:—

$$n = 18.1/(26.9 - 18.1) = 18.1/8.8 = 2.06.$$

Hence, we have that $n = 2$, and that the frequency is $26.9 \times 2 = 53.8$ mc/sec. Now the accuracy of this answer is in all respects the same as the accuracy of the measurement at 26.9 mc/sec., since the inaccuracy in finding the harmonic number n disappears entirely. It should also be clear that there is less possibility of error, the lower the harmonics that are used; this is because the formula for n contains the difference between two quantities that have to be measured with a certain amount of inaccuracy. Because of this, using the fifth and fourth harmonics, for example, might give an answer which leaves some doubt as to which whole number should be chosen for n, whereas with the same signal generator, there might be no ambiguity between the second and third harmonics.

EXTENSIONS OF THE METHOD

We took for our example a case where additional ambiguities are impossible, but if the receiver were a superhet, it would be necessary to ensure that the frequency finally arrived at was not that of the image. In this case, the best thing to do is to make the measurement not on the receiver response at all, but of the frequency of the set's local oscillator. If a calibrated absorption wavemeter is available it can be used as a check that the oscillator is on the right frequency for the band under consideration. Suppose again that the set is a superheterodyne, built for the same band as before. The I.F. is 4 mc/sec., so we know that the oscillator, which we have decided to work on the low side of the signal, should tune between 46 to 50 mc/sec. for the set to receive from 50 to 54 mc/sec. In this case, we feed the signal generator straight into the mixer, ignoring any signal-frequency tuned circuits, and search for receiver responses. The obvious thing to do here is to set the signal generator to 26 mc/sec. and tune the oscillator of the set until a response is obtained. Then, the signal generator is tuned to the next lowest frequency which gives a response, and the actual frequency that is being received is computed, just as for the first example. If the answer comes out to 52 mc/sec., then the oscillator must have been set on either 56 or 48 mc/sec. After this, the signal generator's second har-

(Concluded on Page 48.)

SHOES and SHIPS

*"The time has come," the Walrus said
"To talk of many things. . . ."*

By Special Arrangement with the Walrus

METALWORK

From time to time the writer has been approached by different customers with the same query, "Have you any radio chassis for sale?" The answer is practically always in the negative since chassis ready made to suit particular requirements are hardly ever held in stock.

The suggestion that the person concerned ought to construct their own is generally met with looks ranging from almost frank disbelief to uneasy evasion, but there need be no such uncertainty or terrors felt for this job. In fact, metalwork can become quite an interesting and fascinating hobby for a modest outlay in tools, and jobs of a much more complicated nature than an ordinary radio chassis can be tackled with confidence.

However, since radio chassis are our first consideration, we shall deal primarily with them. For any sort of metal work a good robust vice is essential—most amateur workshops have one and those that have not are lacking the most useful tool obtainable and should take steps to get one. It is usually bought only once in a lifetime, so shouldn't be grudged.

The only other tools necessary for chassis work are a selection of files—round, half-round, and flat—a hand-drill and some drills and a ruler. A hammer is taken for granted.

The most suitable metal for radio work is aluminium although copper can be very useful for certain applications. Eighteen gauge sheet aluminium has the necessary strength for most medium-sized chassis and yet is easy enough to work; twenty gauge, while suitable for small dimension jobs, has not sufficient rigidity without reinforcing; sixteen gauge on the other hand is certainly strong enough, but unless the user has mighty biceps and can heave it into shape, is not recommended.

The first thing to do is to lay out your "set to end all sets" on a bench or board and then measure the size of chassis needed. On to these dimensions must be added twice the depth or turnover required—this is usually 2½ in., but doesn't necessarily have to be. However, tuning spin-wheels, wave-change switches, and like components need that amount.

Fig. 1 shows a chassis having dimensions of 15 in. x 10 in., but allowing for a 2½ in. turndown all round, the overall size to be cut from the sheet of aluminium becomes 20 in. x 15 in. Mark out this size on the aluminium and then with a straight edge laid along the marks, score it deeply with a sharp pocket knife. Turn the sheet over and do the same thing on the other side being careful to strike the same positions. Then put two stout boards along the scorings and hold them firmly in place either by standing on them or clamping in the vice. The free piece of the sheet can then be bent up and down once or twice until a clean break occurs. Carefully done, this can give as good a result as any guillotine. When the piece is cut out correctly, lines 2½ in. in from each edge can be scribed in. An easy marking gauge can be made for this purpose by getting a piece of ¼ in. diameter brass rod or tube and a large skirted or pointer type radio knob. Drill a ¼ in. hole right through the knob and take out the grub screw as well. Select a small belt with a thread to fit the grub

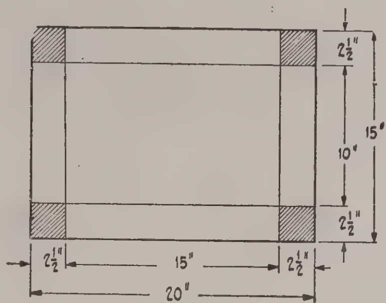


Fig. 1

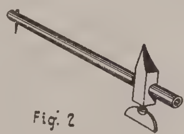


Fig. 2

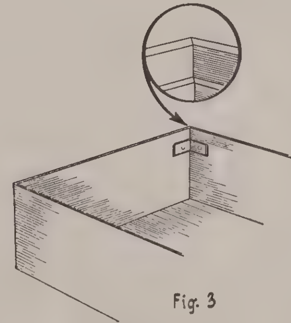


Fig. 3

screw-hole and and across the slot in the bolt solder a piece of flat metal to make a wing bolt. The knob is slipped over the ¼ in. rod and the bolt can be tightened after the knob has been set in any desired position. At the other end of the rod drill a small hole to take a gramophone needle, which can be soldered in position. Fig. 2 shows the arrangement of this very useful home-made tool.

If you make one of these gauges it is only necessary to set it at 2½ in. and scribe all round each edge of the aluminium sheet. The squares formed at the corners must be cut out and for this purpose a hacksaw is best. Tin snips will do the job, but generally leave an unpleaant scolloped edge. Having cut the pieces out, file the edges true up to the marking line and then file them at an angle of 45 deg. so that when the edges are folded the ends butt neatly together as shown in Fig. 3.

The actual folding is most important if a neat job is to be done and for this purpose some angle iron or pieces of 4 in. x 2 in. timber are needed. Clamp the aluminium in the vice between two pieces of angle iron or wood, being very careful to get the edge of the piece of wood or iron laying exactly along the scribed mark where the fold is to be made. Then with a piece of flat timber to give leverage behind the sheet, bend it firmly forward by 90 deg.—a good sharp bend should result.

(Concluded on Page 48.)

The PHILIPS Experimenter

An advertisement of Philips Electrical Industries of N.Z.,Ltd.

No. 60: Screen Modulation of the QQE06/40

Reprints of these EXPERIMENTER articles, complete with illustrations, will be mailed to any address for one year for a subscription rate of 5s. Application should be made to Technical Publications Department, Philips Electrical Industries of N.Z., Ltd., P.O. Box 2097, Wellington.

To the 'phone man, new and unusual methods of modulation are a perennial source of wonder, scepticism, or amusement, acocrding to his point of view. It has been said that there are no new methods of modulation—that they have all been tried out in one form or another, and that most of them have been found wanting. So a good many amateurs whose main delight is 'phone work just stick to high-level modulation, and like it. Be that as it may, there is still a place for something other than a high-powered Class AB or Class B modulator, applied to the plate of a triode, or to plate and screen of a pentode. Many newer amateurs are building transmitters, if not for the first time, as their first medium or high-powered effort. It is all very well for the man who has paid for his 50-watt modulation transformer and for the power supply for his modulators years ago when these things could be had much more cheaply than they can today. Such things do not (or should not) wear out, and it would be folly not to continue to use them. But for a new transmitter, it would equally be foolish not to examine the possibilities of some of the less expensive methods of modulation. Most of them certainly do score on the question of cost, but that is where some of them also stop, and all of them need reasonably careful application if the result is to sound anywhere nearly as satisfactory as a well-designed plate modulated stage.

The growing use of R.F. power pentodes as final amplifiers in transmitters has resulted in more interest being taken in screen modulation than ever before, particularly since the so-called "clamp-tube modulation" made its appearance in the amateur literature some two years ago.

CLAMP-TUBES AND ALL THAT

The idea of clamp-tube modulation grew out of an idea which appeared some time ago for using a small power valve as a device for automatically lowering the screen voltage of a transmitting pentode if the R.F. excitation should fail. The scheme is pretty well-known by now, but in case some readers should not have come across it, Fig. 1 shows the basic arrangement, which is the same irrespective of the type of tube used in the final amplifier, and even of whether the stage is single-ended or a push-pull one. The amplifier is grid-leak biased, and no protective cathode bias is used, since this is unnecessary when the clamp tube is used. R_1 is the normal screen-dropping resistor, and has the same value as is used for the R.F. valve when the clamp tube is not used. The reason for this is that when R.F. excitation is present, the negative bias produced by the amplifier grid current biases the clamp tube to beyond cut-off. Thus, as long as the excitation is there, the clamp tube behaves as if it were entirely absent, and the R.F. amplifier operates normally. However, if the excitation should fail, the bias on both tubes falls to zero, and the clamp tube draws as much plate current as it can, in view of the resistor R_1, which now acts as a plate load resistor for it. Under these conditions, the plate of the clamp tube "bottoms," or in other words, drops smartly to somewhere in the vicinity of 50 volts. When this occurs, it takes the screen

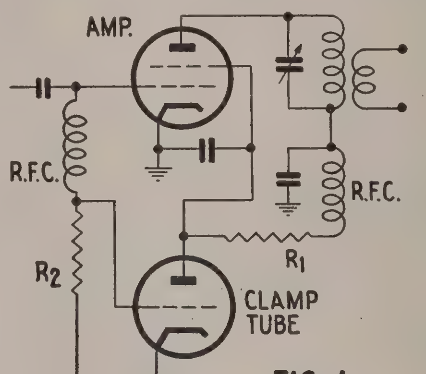


FIG. 1

of the R.F. amplifier with it, since the two are directly connected together, and the R.F. valve is protected from damage through overheating of the screen. For this purpose, a triode-connected EL41 is a very satisfactory valve, and applied to the Philips QQE06/40, as used in the final of the Philips transmitter, it works very well. The plate current does not drop very far, because although the screen is at a low voltage, the grid bias is zero, but that is really unimportant. The screen voltage of about 50 is low enough to prevent the plate from exceeding its rated dissipation, and at the same time, it prevents the screen itself from doing likewise. A good many people do not seem to realize that the most delicate part of a pentode is its screen, and that consequently, the measurement of plate current alone is no criterion of whether or not the valve is being abused. Screen dissipations on even quite large pentodes are very small, and should on no account be exceeded; the most prevalent cause is that of running the valve with no load, tuned to the plate current dip. Under these conditions, the screen current can be larger than the plate current, and while this is often very low, it exceeds the allowable screen dissipation by quite a lot,

From the protective circuit of Fig. 1, it is but a short step to the circuit of Fig. 2, in which the clamp tube circuit is slightly modified in order to use it as a modulator.

The clamp tube is given some cathode bias, and an additional dropping resistor is inserted between the plate of the clamp tube and the screen of the R.F. amplifier. The grid of the clamp tube is removed from the amplifier grid leak, and is provided with an audio input circuit instead. The additional screen dropping resistor is bypassed for audio frequencies by a large condenser of 0.5 μf. or more. Put like this, the scheme looks simple enough, and so it is, once the correct circuit constants have been worked out, but its operation is not quite so simple as might appear at first sight.

In the first place, the amplifier's screen voltage cannot be run at the same voltage as it is for C.W. or for plate-and-screen modulation, for under screen modulated conditions, the power output at the positive modulation peaks cannot be greater than the C.W. power output. This means that the carrier

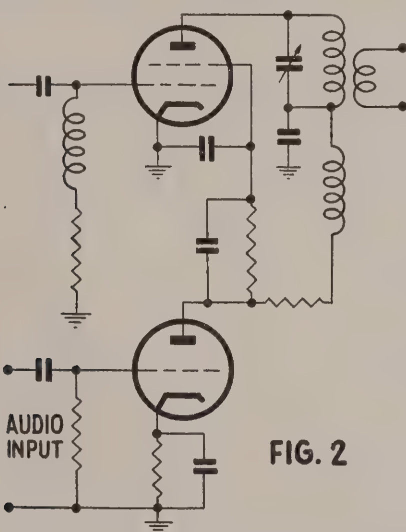


FIG. 2

power must be no more than a quarter of that obtained under C.W. conditions. For example, if the amplifier is run at 100 watts input on C.W., the carrier power under screen modulation cannot be more than 25 watts. This might seem very unfortunate, but it is a feature of all efficiency modulation systems, whether grid modulation, screen modulation, or suppressor. It is, in fact, part of the price that one must pay for avoiding the installation of a high-powered plate modulator!

It can be seen, therefore, that the circuit of Fig. 2 must fulfil certain conditions. First of all, the amplifier must be provided with approximately half its normal screen voltage. If the screen characteristic is linear, this will mean that with no modulation, the power output will be a quarter of the C.W. figure. Secondly, the modulator must be capable of swinging the screen voltage from zero volts to twice the unmodulated value, without introducing too much distortion either of the audio frequency waveform itself, or of the modulated envelope. In order to do this, the modulator has to function as a resistance-coupled amplifier, with a load which consists of the plate load resistor, in parallel with the input resistance of the screen circuit. It has to supply a certain amount of power to the screen circuit, just as a plate modulating amplifier has to supply audio power to the plate circuit of the modulated amplifier. Thus although the use of screen modulation results in a considerable economy of parts, it does not gain quite as much as might be imagined at first sight.

The purpose of the extra dropping resistor between the plate of the modulator and the screen of the amplifier is that unless the screen voltage is lower than that of the modulator plate, the latter will not be able to swing the screen down to very low voltages without introducing excessive distortion. Those whose memory goes back as far as the days when Heising modulation was the thing, will remember that exactly the same trick was used there so that one modulator could reduce the plate voltage of the R.F. modulated amplifier to zero before its own output waveform became distorted. It is quite a simple matter, if curves are available for the modulator valve, to calculate what sort of a job it will make of screen modulating a certain R.F. amplifier. Suppose, for example, that the screen of the amplifier draws 10 ma. at 125 volts with normal plate loading and grid excitation. This represents a resistance of 12,500 ohms, and it is clear that the modulator must deliver to this resistance a power of half the D.C. screen power, or 0.75 watts. This seems very little, but for a resistance-coupled amplifier it is a good deal, and it will probably be found that a much larger valve has to be used as the modulator than might at first have been expected. Later in this article, a practical circuit, with values will be given for clamp-tube modulation of a QQE06/40.

For using the scheme of Fig. 2 where it is desired to use 'phone and C.W. with the same transmitter, the simple modifications given in Fig. 3 will enable a quick change-over to be made. The grid leak of the clamp tube is simply connected in parallel with that of the amplifier in the C.W. position, and is large

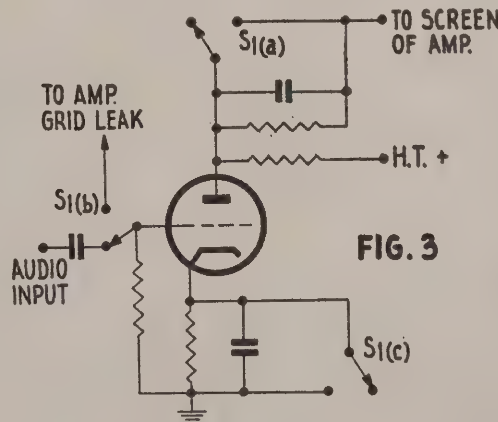


FIG. 3

enough to have no appreciable effect on the value of the latter. The cathode biasing circuit of the clamp tube is short-circuited, so that in the C.W. position the tube is not biased back by the cathode resistor should the excitation fail. Also, the extra dropping resistor to the screen of the amplifier is short-circuited, leaving the normal value for C.W. operation at full screen volts.

(Continued on Page 48.)

The Story of Baird and Television

By G. PARR, M.I.E.E.

No one is better qualified to assess the value of Baird's contribution to television than Mr. Parr, Secretary of the Television Society, who gained an intimate knowledge of the details of TV. development through his editorship of "Electronic Engineering" during a key period in television progress.

In the autumn of 1951 the London County Council erected a plaque on the wall of 22 Frith Street, Soho, marking the house where the television of living images was first demonstrated by John Logie Baird in 1926. This year, the Bexhill-on-Sea Corporation has erected a tablet on the house in Station Road, where he spent the last years of his life, and his birthplace in Helensburgh is to be similarly commemorated.

The erection of these memorials to a man who, in the opinion of many, was merely an ingenious experimenter, and not so very ingenious at that, has tended to revive a controversy which has always been associated with the name of Baird.

At the recent Television Convention one speaker openly expressed his disapproval of such tributes—a singular comment to an audience gathered to hear about the British contribution to television. For the fact remains that the first public television service in the world was by the Baird system, broadcast by the B.B.C., and it was he who established the first television transmitter (2TV) in Long Acre in 1928 at a time when other countries were waking up to the possibilities of this new science.

In the few years between his first demonstrations and the first public transmission, Baird had shown all the aspects of television that are well known today: outside broadcasting, large screen pictures, colour, and even stereoscopy. Very few modern viewers remember that the first outside broadcast took place in 1931, when the Derby was televised—an event of historic importance, even though the horses could hardly be distinguished from humans except by the number of legs.

With all this pioneer work to his credit, what has prevented Baird from being acclaimed as Marconi has been acclaimed? Marconi did not invent radio any more than Baird invented television. In some ways his early work and experiences were similar to Baird's. The foundations had been laid for him by earlier workers, although, like Baird, he filed patents of his own. His early apparatus was crude, and he had little more than faith in the future when he arrived in Britain. Baird had immense faith in the future when he set up in London. But where Marconi found an enthusiastic supporter in Sir William Preece with the authority of the Post Office behind him, Baird had no such support in his early days, and this was to prove a more powerful handicap than he ever considered.

The cause of the reluctance to hail him as a great inventor, worthy to rank with Marconi, is to be found partly in the circumstances of his early work, partly in his early associates, and partly in the man himself.

Baird was not a scientist in the accepted sense. He had electrical experience and had been technically trained at Glasgow Technical College.

There is no doubt that he owed his inspiration to the accounts of Shelford Bidwell, who first suggested the use of a selenium cell to convert light into electrical impulses, and by Rosing, Nipkow, and others who had proposed a system of scanning. The first of Baird's experiments was a practical realization of the Nipkow scheme, using a cardboard disc with spirally arranged holes as in Nipkow's patent of 1884.

He was confident, however, that by making use of the modern achievements in radio—the photo-cell, the thermionic amplifier—he could produce a workable television system.

His first apparatus was as crude as only lack of money and lack of facilities could make it. Nevertheless it worked, and Nipkow's scheme had never progressed beyond the drawing stage.

Encouraged by this, Baird inserted an advertisement in *The Times*, which should have attracted attention by its astute innocence:

> Seeing by Wireless. Inventor of apparatus wishes to hear from someone who will assist (not financially) in making working models.

A reply came from Mr. Odhams, of Odhams Press, but after taking technical advice Mr. Odhams declined an offer of a twenty per cent. share in the invention for £100. Nevertheless, Baird benefited from the advertisement in being able to obtain some much-needed apparatus: "three DER valves, three LS.5 power valves, two intervalve transformers, and a 3-valve note magnifier."

Eventually, with help from Mr. Will Day and Mr. Selfridge (who staged the first demonstrations of television to the public in his London store), Baird was enabled to come to London where he established himself at Frith Stret and later at Long Acre. A generous sum of £500 from his cousins put his newly formed company, "Television Limited," on a reasonably sound basis.

At this stage he was joined by a former business associate, Captain O. G. Hutchinson, who, in spite of vigour and determination, was temperamentally incompatible with Baird. Nevertheless, with Hutchinson's aid, television was demonstrated to the members of the Royal Institution, as representing the scientific world, and to *The Times*, as representing the Press, the historic date being Friday, 27th January, 1926.

The pressing need was now money, and the co-operation of the B.B.C. Without money the company could not be developed, and without the B.B.C. it could never succeed. Hutchinson was able to interest Vowler & Co., whose partner, Colonel Ian Anderson, was instrumental in launching a new company in 1928, Baird International Television, with a capital of £700,000. Both Baird and Hutchinson had shares in the new company, and when this was again subject to reorganization, Baird was offered £125,000 for his shareholding, and a salary of £10,000 a year. It is an interesting sidelight on the outlook of the two associates that Hutchison considered £125,000 totally inadequate for his shares and Baird declined the offer because he would not know what to do with the money.

The financial deal was concluded only just in time, as on the following day the American Telegraph Co. in New York unexpectedly announced their own demonstration of television, and the monopoly which Baird had held for a year vanished.

An era of prosperity now began for Baird and his new company, and demonstrations were given all over

the country including one at the British Association at Leeds. The lay press were acclaiming the latest marvel, while the technical press were sceptical.

It is here, in the writer's opinion, that Baird failed to establish himself in the eyes of those who could have done him service later. Convinced in his own mind that his system was good, he avoided technical discussion and made little attempt to enlist the support of many whose scientific reputations would have carried weight in the quarters where it was most needed. It was of little use reiterating in the Press that television was an accomplished fact and shutting one's eyes to its imperfections. Apart from the initial demonstration to the members of the Royal Institution, there is no record that he ever proposed to read a paper to any other scientific body or that he replied to the many well-informed opinions that were expressed on the future of his developments.

The next step was to enlist the help of the B.B.C. in putting over experimental programmes. Mr. Sydney Moseley, who had joined the Board of the Company and was a whole-hearted supporter of Baird Television, fought strongly on their behalf and succeeded in obtaining the agreement of the Postmaster-General to allow facilities for experimental transmissions by the B.B.C. These began in 1929 with vision only, and in 1930 both vision and sound were radiated on the two Home wavelengths. A landmark in these experimental transmissions was the first televised play *The Man with the Flower in his Mouth,* which was performed on July 14, 1930.

Two years later the B.B.C. installed a mirror-drum transmitter at Portland Place and regular "professional" television was on the air. The standard of 30 lines, 12½ pictures per second had been determined at the inauguration of television, and Baird seems to have been content to allow this to continue without definite indication that it was no more than a beginning. He made various experiments in other directions, but in the meantime his rivals were developing their own systems with all the weight of their technical staffs behind the experimental work. It must be remembered that Baird was wedded to mechanical systems of scanning, in which he showed his ingenuity from the start, and it was partly his reluctance to realize that mechanical television had a very limited scope that led to his ultimate failure. For failure it was; by the end of 1930 the money had run out. The expected sale of television receivers proved quite inadequate to bring any return for the amount invested, and the necessary expenditure on publicity far exceeded the return in orders and equipment.

Television Ltd., the original parent company, had gone into voluntary liquidation, and the market value of the shares in Baird Television Ltd. had fallen to fourpence.

Mr. Moseley recounts the intricate and finally successful manoeuvres which he made to obtain backing in America and London which finally resulted in the control passing into the hands of the Gaumont-British group.

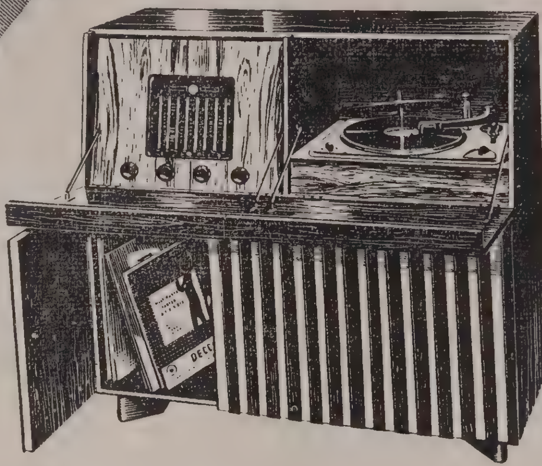
Baird at last began to see what lay ahead. The cathode-ray tube, which had arrived a few years after his first experiments, was the doom of the mechanical receiver, and the newly formed company began to develop electronic television. In 1933, another demonstration was given to the British Association of a 120-line picture on a cathode-ray tube, and the possibilities of short-wave transmission had already been explored.

But other firms were overtaking the Baird organization, among them the powerful E.M.I. company in collaboration with Marconi's. The B.B.C. were offered two improved systems of high definition television, one by Baird of 240 lines, 25 pictures per second, and the other by Marconi-E.M.I. of 405 lines, 25 pictures per second interlaced scan. After a trial period of both systems in 1934, the interlaced system won the day, and with its victory went the final hope of the Baird Company to control British television. The war dealt Baird another blow, and although he continued his experimenting as best he could, he was handicapped by lack of funds and lack of outside interest. His inventive ability was turned to colour television, and he demonstrated a two-colour picture in 1941 made by superimopsing two separate images from cathode-ray tubes on to one screen. This was dismissed in some quarters as impractical, but its worth noting that the Radio Corporation of America developed a similar system later.

Baird died on June 14th, 1946, a short while after the reopening of the B.B.C. television service. Of all the money that had circulated around his name and his projects, very little had come his way. Whatever his shortcomings in the technical sense, he was a man of whom no one spoke ill. Quiet, courteous and persistent, he went on the lines that he thought were right, and although others outstripped him in the quest for the perfect picture, he was the stimulus that set them on the quest.

It is therefore as the founder of television, not only in Britain but all over the world, that Baird deserves recognition, and a memorial plaque or two does not seem too elaborate a tribute to pay to one who ushered in one of the great social changes of our time.

(By permission of "Discovery," in the August, 1952, number of which this article originally appeared.)



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Radio and Television

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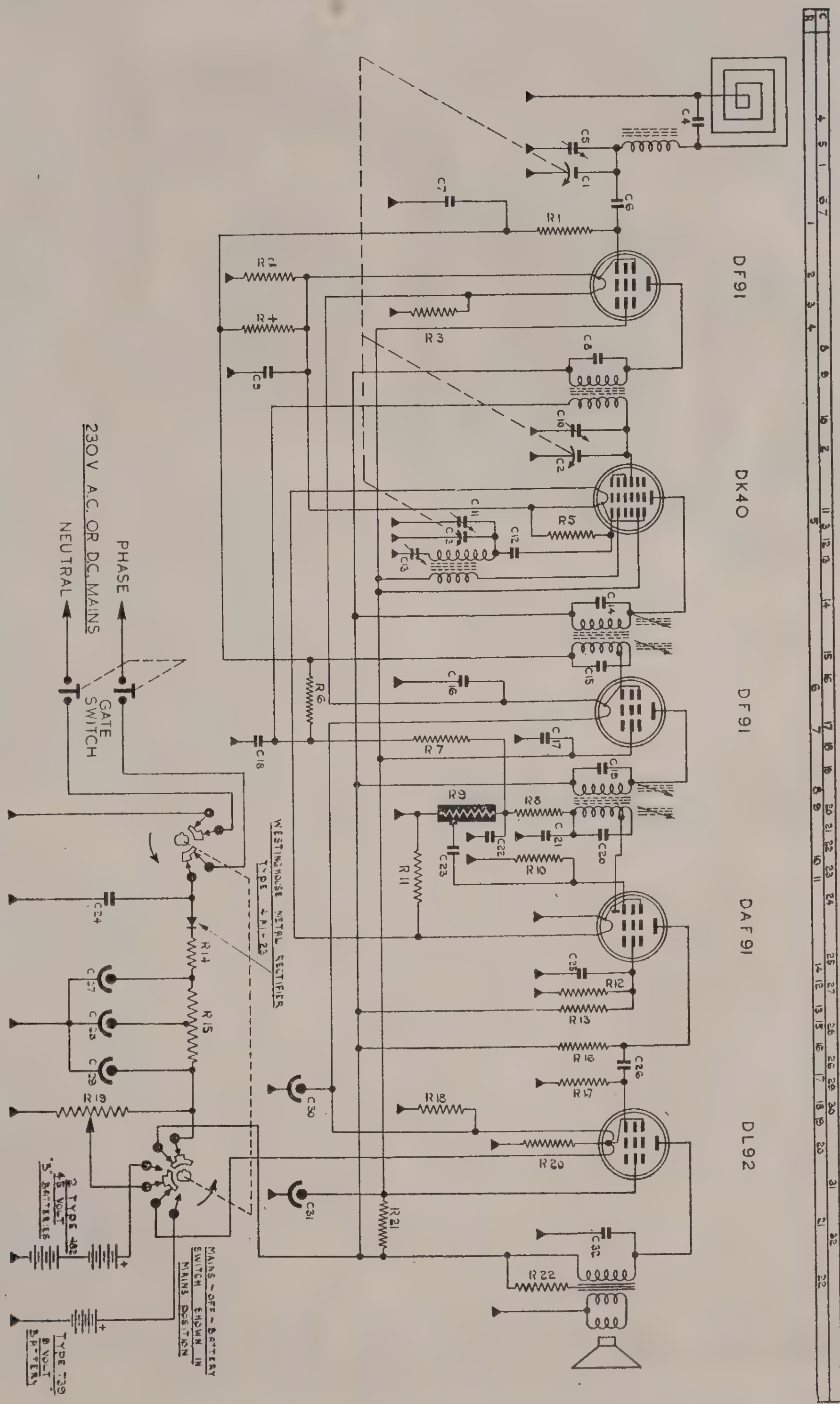
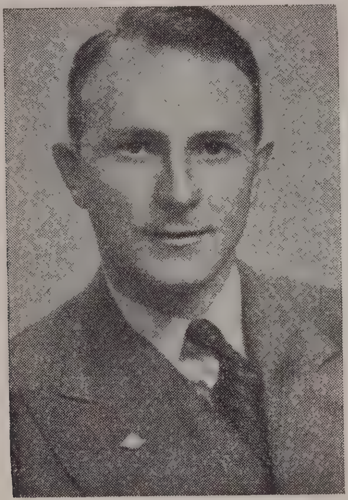


WELLINGTON RADIO TRADERS' ASSOCIATION

In presenting his Annual Report to the annual general meeting of the Wellington Radio Traders' Association on 18th August, the President, Mr. W. L. Young, drew attention to the increased strength of the Association and congratulated the membership committee on their sterling work. The interest of individual members was particularly encouraging, he felt.

Contending that the public are becoming more selective in their buying, Mr. Young urged traders to realize that they no longer enjoy a sellers' market. "While in some ways this makes sales harder to secure," he said, "the alert dealer who presents his merchandise well will find there is still plenty of business to be done." Traders,



W. L. YOUNG
Re-elected President

other than legitimate radio retailers, who previously stocked only the odd set, will now fade out of the picture, and Mr. Young advised traders to keep before the public the after-sales facilities which are always promptly available from bona fide traders.

He revealed that the sudden impact of credit restrictions has caused temporary embarrassment to some dealers. It is not anticipated that the currency restrictions will unduly affect the range of radio receivers available, but, in the appliance field, which now forms part of practically every trader's business, a reduction in the range of goods can be expected.

Discussing the question of radio interference, Mr. Young informed members that this was being closely watched, the Federation being actively engaged in endeavours to reduce the menace of interference.

ELECTION OF OFFICERS

The election of officers resulted as follows:—

President: Mr. W. L. Young (re-elected).

Secretary-Treasurer: Office of New Zealand Employers' Federation.

Executive: Messrs. D. B. Billing, L. D. Jenness, J. S. Oxley, R. B. Fowler.

Auditor: Gordon, Berry, and Tait.

Delegate to Executive of N.Z. Radio Traders Federation: Mr. W. Young.

Delegates to any General Meeting of N.Z. Radio Traders' Federation: Messrs. W. Young, D. B. Billing.

The financial statement revealed that, in spite of the increased membership, the finances of the Association were extremely weak, and it was decided that in addition to the membership drive, the subscription for wholesalers should be increased by £2 2s.

SCOPE OF FEDERATION AND ASSOCIATION ACTIVITIES

Consideration was given to the report of the special committee set up at the previous meeting to inquire into the scope of the Federation and Association activities with regard to electrical appliances, etc. In its findings, this committee reported that of the present Association membership, practically 100 per cent. also sold such appliances. If the Association decided to take no further action, and these members wanted some protection in such trading, they would have to join some other Association for this purpose. If the Radio Traders' Association did assume this additional responsibility, its functions would include:

- Maintenance of price levels and reasonable margins.
- Maintaining a watching interest on guarantees as they affect dealers.
- Watching the supply position as it affects dealers.
- Price control inquiries.
- National advertising, featuring radio traders as a section of retailers.

Naturally an additional fee would have to be charged for this work, and the Committee recommended a minimum additional charge of £1 1s. per annum. It was pointed out that it would cost members a good deal more if they had to join another organization to protect their interests.

Though it was felt that the Associtionn could, with benefit, co-operate with any outside organization with common interests in this regard, it was not recommended that traders, other than radio traders, should be admitted to membership, supposing the activities of the Association were expanded. The committee considered that only in cases where the business is predominantly an appliance one could members other than radio dealers be accepted, and it was recommended that the Association should not solicit membership from other than radio dealers.

Summarizing, therefore, the committee recommended that, as practically 100 per cent. of the present membership was also involved in the appliance field, the activities of the Association should be enlarged to include those interests.

After much discussion of all aspects of this question, it was finally resolved that the report of the special committee be adopted and forwarded to the Federation for favourable consideration, subject to attention being drawn to the fact that increased fees would probably be payable, and that it would be necessary first to ascertain whether the secretarial services would be available.

(Concluded on Page 48.)

USING THE "807 STANDARD AMPLIFIER"

(See *Radio and Electronics*, September, 1952)

In view of the somewhat unusual input arrangements, it is essential to go about connecting pick-ups and radio tuners to the amplifier in the proper way. Since magnetic, crystal pick-ups and radio tuners need slightly different treatment, it will be best if we deal with the three under individual headings.

(1) Magnetic Pick-ups:

Under this heading, we can distinguish between three main types. First of all, there is the more or less old-fashioned type of magnetic, which is relatively heavy, and which uses standard gramophone needles. This type does not ordinarily need any bass compensation, because this is built into the pick-up itself by means of arm resonance. Such pick-ups cannot give the finest quality of reproduction, but there are numbers of them still in use. They can be connected directly to the amplifier input terminals and used with the switch in the "radio" position. It may be that for best results the pick-up will need to be shunted by a certain amount of resistance, and the effect can be tried of placing various resistance values in parallel with the pick-up. Suitable values to try range from 25k. to 200k., and the value should be chosen for the best sounding results.

The second type is the modern lightweight pick-up with permanent stylus or using miniature needles. These types need bass compensation, and so are used with the switch on the "78" position. If the instructions with them recommend a certain loading resistance, this should be connected across them. Some pick-ups of this kind require quite low loading resistors and enable a useful amount of top cut to be obtained simply by making this resistance smaller. The size of resistor should never be greater than that recommended by the makers, but this can be made smaller if it is desired to reduce the high-frequency response somewhat. If the pick-up is one with two heads, one for L/P and one for 78, the compensation switch will, of course, be put in the appropriate position for the head actually in use.

Some of these qood quality pick-ups have slightly more output than the 6J7 can handle without distortion. If this is the case, the loading resistor can be split into two parts, making a voltage divider out of it, so that a fraction of the total output can be applied to the amplifier.

The third case is that of the very low-output type of magnetic head which requires more amplification than the amplifier can provide. Sometimes the makers of these pick-ups provide step-up transformers that provide a 5- or 50-to-1 step-up in output voltage. For this circuit, the 5-to-1 transformers can be used, and will enable enough output to be obtained to use the pick-up without giving enough to fully load the amplifier. In a case like this, the best answer is to install an additional low-gain stage, such as a 6J5, or 6C5, giving a gain of some 14 times.

(2) Crystal Pick-ups:

Under ordinary conditions, crystal pick-ups need quite different compensation from magnetics, but where there is plenty of gain to spare, as here, a trick can be resorted to to make the crystal suitable for use with the same compensation circuits that are used for magnetic heads. This trick is nothing more than connecting across the pick-up a resistor of from 25k. to 100k. Usually, a figure of 50k. will be found suitable, and a bit of experimentation can be indulged in to obtain the results which sound best to the ear. What happens when a crystal pick-up is shunted like this is that the response curve is flattened out until it looks just like that of a magnetic pick-up, so that the standard form of compensation can be used.

(3) Radio Tuners

Most radio tuners, fortunately, produce a good deal more output voltage than this amplifier needs, so that a simple arrangement can be used for taking only a fraction of the tuner's output off to the amplifier. Fig. 3 shows the best way of doing this. A tapping is made on the diode load and the output of this tap is taken to the input terminal of the amplifier. The actual resistance to ground does not matter very much in the case of the tuner, because changes in this can only change the gain of the first stage, when it is switched to the "radio" position. If the tuner has a variable volume control, then it is quite in order to take the output of this control to the input terminal of the amplifier. This will give two volume controls in circuit, but this does not matter very much. The one on the set can be put at any suitable spot and the control in the amplifier used as the gain control proper.

"R. & E." TECHNICAL PHOTOGRAPHS

Copies of original designs produced in our laboratory and featured in these pages are available. Prices are: Size 6 in. x 4 in, 3s. 6d.; 8 x 6, 4s. 6d.; 10 x 8, 5s. 6d. Please remit cash with order to Radio and Electronics

Two Strobotron Circuits

(Continued from Page 11.)

great enough for the negative ones to function, and not great enough for the positive ones to have any effect. In this circuit, a different approach is used, that is much more positive in action. The diode removes the positive pulses altogether, leaving only the negative ones, and preventing the possibility of double triggering at the source. The strobotron circuit is the same as before, and thus requires no further comment.

SOME ADDITIONAL POINTS ABOUT THE CIRCUIT

It was mentioned above that there is very little difference between the characteristics and ratings of the 631-P1 and the NSP1. In case some readers should have the former tube, it should be mentioned that its upper frequency limit is 240 cycles per second, and not 300, as is the case with the latter tube. Thus, if the 631-P1 should be used, it would be wise to limit the upper frequency of the oscillator, in either circuit, to 240 c/sec., so as not to exceed the tube's ratings.

In our own experimental circuit, we used the valves shown in the component list. Actually, there is no reason why other double triodes should not be used, and the only place in which the choice of valve will make much difference is in the oscillator section of Fig. 2. The use of a different valve type for V_1 and V_2 may necessitate a change in the value of the 800-ohm cathode resistor in the circuit of V_2, but no other modifications will be necessary. This resistor was chosen so that at the low-frequency end of the ranges, the circuit was just oscillating at the output level at which it starts to square off the waveform of the output. Under these conditions, it oscillates slightly harder as the frequency is raised, and this adjustment ensures that the oscillator will always start. If different valves are used, all that need be done is to set the frequency control to the low-frequency end, and then adjust the cathode resistor so that the output just starts to become clipped on one side. A fixed cathode resistor can then be installed.

There is nothing about the circuit that need deter anyone who has not had many dealings with circuits which produce peculiar waveforms. It is very nice to have an oscilloscope, and to see what goes on in the various stages, but it is quite unnecessary as far as getting the circuits to work is concerned. Needless to say, if the Fig. 2 circuit is attempted, the construction should be in line with the circuit. That is to say, it should be solid, with all resistors and condensers solidly terminated so that the parts cannot shift. The strobotron can be mounted in a reflector at the end of a flexible lampstand, the leads can be taken down the inside of the flexible supporting tube, and, as the voltages are not high, no very special precautions need be taken with regard to insulation.

If desired, a reflector could be built into the case in which the circuit is built, and the circuit so laid out that when the lamp and reflector are pointing away from the operator, the dial of the frequency control is ready to hand for adjustment and reading.

The circuit can be very compactly built, if desired, since normal audio frequency layout and wiring practice can be followed.

CALIBRATION

The calibration of the oscillators in these circuits really does need an oscilloscope, and an accurately calibrated audio oscillator. The best plan is to put the oscillator output on one set of the 'scope plates, and the output of the multivibrator, or the output of the squaring stage on the other set of plates. Then, when the pattern consists of a single closed loop, without any cross-overs, it can be assumed that the frequency of the stroboscope's oscillator is the same as that of the test oscillator. In this way, the test oscillator can be set to the desired calibration points, and the instrument's oscillator set to the same frequency with the control knob. The position of the pointer is then marked with the appropriate frequency, or with that frequency multiplied by 60 if the calibration is to be in R.P.M. Alternatively, the 50-cycle mains can be used as a calibrating signal, but since the oscillators in the stroboscope circuits do not produce sinusoidal outputs, the multiple patterns are a bit difficult to interpret except at very low multiples of the mains frequency. The audio oscillator is thus much the easiest and best.

Tube Data

(Continued from Page 14.)

In the event of a complete or partial failure of the oscillator circuit the cathode current of the mixer would become excessive. It is therefore desirable to operate the valve with cathode bias. The cathode current at optimum drive is 6.0 mA, so that a 500 Ω cathode resistor is required. Under these conditions any value of grid leak less than 1 MΩ may be used but a high value is desirable to limit grid current. The grid current will be zero for an oscillator voltage less than that required to overcome the grid-current starting point and to drive the valve into grid current on the oscillator peaks.

The high mutual conductance of the ECC81 makes it an efficient local oscillator at high frequencies and this tube may be used with any of the conventional oscillator circuits, of which Fig. 4 gives an example. Typical performance figures for a frequency changer of this type operating in conjunction with a push-pull R.F. amplifier as illustrated in Fig. 3 are: total gain (between 50 Ω aerial and 2.2 kΩ anode load of the mixer) 31 db., bandwidth 7 mc/sec., noise factor 9. When this circuit is used in a television receiver operating without inter-carrier sound or in an F.M. receiver, vibrations in the air surrounding the tube or of the chassis may give rise to a modulation of the oscillator frequency. This can be avoided by using a screening can around the tube and, if necessary in a particular case, a resilient tube holder.

TECHNICAL DATA

Heater Data

Heating: indirect by A.C. or D.C.; series or parallel supply.

Heater voltage	V_f	6.3	12.6 V
Heater current	I_f	0.3	0.15 A

Base Connections and Dimensions (in mm.)

Fig. 5.

Mounting position: Any

Capacitances

	Section 1	Section 2
C_{ag}	1.45	1.45 pF
C_g	2.5	2.5 pF
C_a	0.45	0.35 pF
C_{ka}	0.15	0.15 pF
C_{kf}	2.5	2.5 pF
$C_k(g+f)$	5	5 pF
$C_a(g+f)$	1.6	1.5 pF
C_{gg},	<0.005	pF
C_{aa},	$<$ 0.4	pF

Typical Characteristics

Anode voltage	V_a	170	200	250 V
Grid bias	V_g	—1*	—1.5	—2.35 V
Anode current	I_a	10	10	10 mA
Mutual conductance	S	6	5.5	4.9 mA/V
Amplification factor	μ	62	57	43

*At this adjustment grid current may occur. In case where this is inadmissible it is advisable to adjust the bias at —1.5 V.

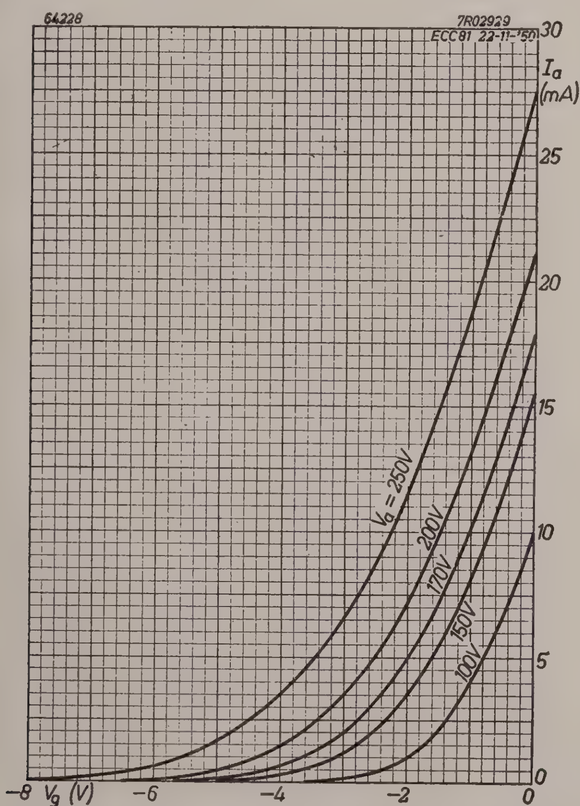


Fig. 6.—Anode current plotted against grid voltage, with anode voltage as parameter.

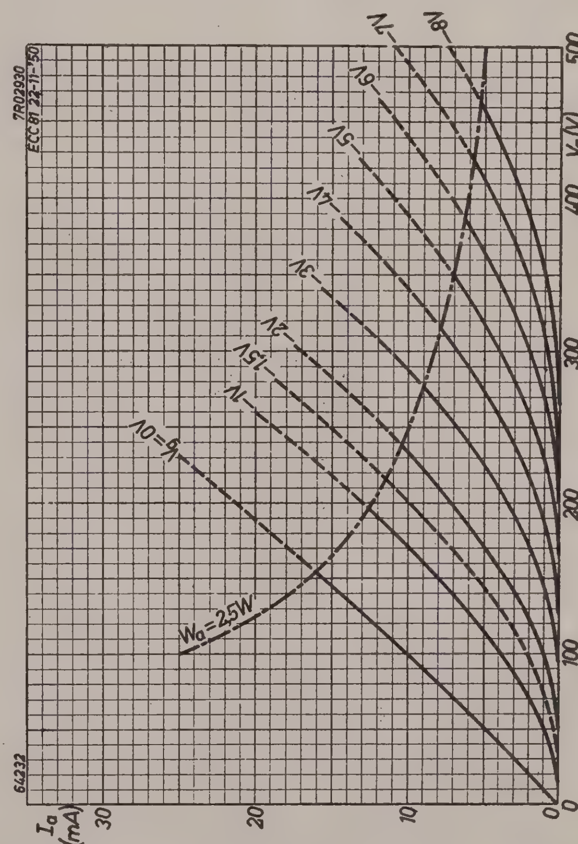


Fig. 7.—Anode current plotted against anode voltage, with grid voltage as parameter.

to avoid an excessive spread in performance from tube to tube due to the rapid decrease in conversion conductance at low oscillator voltages. The curves were obtained with a grid leak of 1 MΩ and no cathode bias was used. At $V_a = 170$ V the grid current for optimum drive is 3.3 μA, which represents a bias of 3.3 V.

Limiting Values (each section)

Anode voltage at zero anode current	V_{a0}	max. 550 V
Anode voltage	V_a	max. 300 V
Anode dissipation	W_a	max. 2.5 W
Cathode current	I_k	max. 15 mA
Heater voltage during warming up period for both sections together		
(for V_f normal = 6.3 V)		max. 9.5 V*
(for V_f normal = 12.6 V)		max. 19 V
Voltage between heater and cathode	V_{kf}	max. 90 V
External resistance between control grid and cathode with automatic bias	R_g	max. 1 MΩ
External resistance between heater and cathode	R_{kf}	max. 20 kΩ

*Where the ECC81 is used in a receiver or any other circuit with series supply of the heaters it is necessary to use a device limiting the initial current after switching on. This may be an NTC resistor in series with the heater chain.

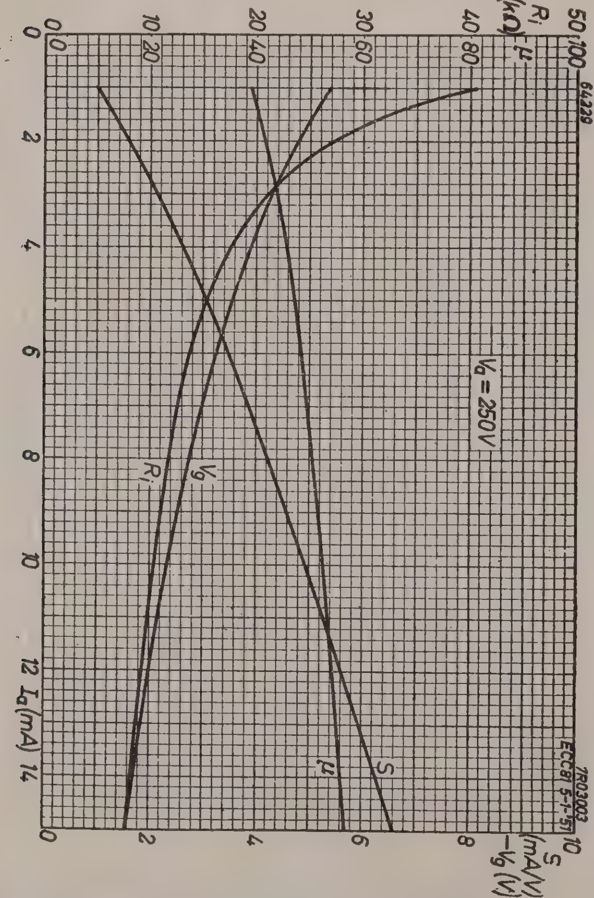


Fig. 8.—Mutual conductance, amplification factor, internal resistance, and grid voltage plotted against anode current, for anode voltage of 250 V.

Trade Winds

It is with great interest that we learn of the formation of Loudspeakers (N.Z.) Ltd., which we understand, has acquired a long lease of property in Kent Terrace, Wellington. The latter is being considerably altered and modernized to suit requirements.

Loudspeakers (N.Z.) Ltd., will take over the Rola loudspeaker manufacturing activities previously carried on by the Swan Electric Company in Hope Gibbons Building. Swan Electric, however, will retain its exclusive distributorship of Rola loudspeakers and any other products of Loudspeakers (N.Z.), Ltd.

The shareholding in the new company is equally divided between the Swan Electric Company Limited, 23 Chancery Street, Auckland, and the Rola Company (Aust.) Proprietary Limited, of Melbourne, Victoria.

Directors of the company are Mr. William J. Blackwell, representing Swan Electric, and Mr. A. L. C. Webb, representing the Rola Company.

* * *

We learn with interest that Bill Blackwell, Managing Director of Swan Electric Company, Limited, has made a sudden visit to San Diego, in Southern California, for discussions with his American associates. We do hope that when business affairs are concluded that Bill finds time to relax a little in the wonderful Californian climate and recuperate somewhat from the strenuous time he undoubtedly has had of late.

Radio Industry Council Specifications

We are grateful to the Radio Industry Council of 59 Russell Square, London, W.C.1, for supplying complimentary copies of the following specifications, which may be inspected by those interested at our offices, 46 Mercer Street, Wellington, C.1.

Sections 1 and 2 of RIC/151: Switches, dolly operated.

Sections 1 and 2 of RIC/154: Switches, wafer, rotary.

Sections 1 and 2 of RIC/251: Valve holders, electronic receiver types.

These specifications have been produced by agreement between B.R.E.M.A., R.C.E.E.A. and R.E.C.M.F., whose individual contributions to the substance of the documents have been co-ordinated and edited by the Technical Specification Committee of R.I.C., and have been authorized for publication by the Technical Directive Board of R.I.C., on which all the constituent associations of R.I.C. are represented.

For the time being these specifications are meant for use internally within the industry, but it is intended to submit them in due course to B.S.I. It is hoped that, by the time that stage has been reached, it may have been possible to co-ordinate the respective requirements of the industry and the Services for these components in comprehensive national standards.

The following additional sections to specifications previously issued have also been received. These new sections complete their respective specifications:

Section 3 RIC/111: Resistors, fixed, wirewound, non-insulated.

Section 3 RIC/122: Resistors, rotary, variable, composition track (with or without switches).

Section 3 RIC/133: Capacitors, fixed, ceramic dielectric, Grade I.

Further copies of these new specifications and the additional sections may be obtained on application to the Radio Industry Council, 59 Russel Square, London, W.C.1, the charges (all post free), being as follows:—

RIC/151: Sections 1 and 2 together, 6s. per copy.

RIC/154: Sections 1 and 2 together, 6s. per copy.

RIC/251: Sections 1 and 2 together, 5s. 6d. per copy.

RIC/111: Section 3, 5s. per copy.

RIC/122: Section 3, 1s. 6d. per copy.

RIC/133: Section 3, 3s. per copy.

For the information of those interested, charges for the three completed specifications are as follows:—

RIC/111: Sections 1, 2, and 3 together, 9s. per copy.
RIC/122: Sections 1, 2, and 3 together, 5s. per copy.
RIC/133: Sections 1, 2, and 3 together, 8s. per copy.

Obituary

It was with great regret that we learned from the Swan Electric Company, Ltd., of the sudden and unexpected death of its major shareholder, Henry Steven Tenny.

A citizen of the United States, Mr. Tenny lived in semi-retirement in Southern California for the past few years. There he maintained a small factory for the production of fine optical parts of extremely accurate correction. During the war, he not only invented an anti-reflection grinder which enjoyed wide use, but his plant also manufactured lenses for periscopes.

As a noted optical consulting expert for the armed forces, he journeyed east, early in the war, at the Navy's request, to observe an optical factory producing two lenses at once. Upon his return, he astonished experts by inventing a process for the polishing of 10 lenses simultaneously.

Foremost among the pioneers in the development of modern moving coil loudspeakers, in conjunction with a partner, he established the original Rola loudspeaker factory in Cleveland, Ohio, and later the British Rola Company in England, of which concern he was Managing Director for some years.

Despite his technical qualifications and scientific attainments, Henry Tenny was friendly and unassuming in nature, justly earning the admiration of all who knew him.

Extension of R.N.Z.A.F. Morse Practice Transmissions

We have been advised by the Royal New Zealand Air Force that, commencing on Monday, 8th September, 1952, the following exetnsions to their morse practice transmissions from ZKF are taking place:—

1100–1115 hours, 30 words per minute.
1120–1135 hours, 25 words per minute.
1140–1155 hours, 20 words per minute.

These transmissions are on 6000 kc/sec. only, and take place five days a week, from Monday to Friday inclusive. The material used is plain language.

Letters from Correspondents

A correspondent signing himself "High-Fidelity" writes as follows concerning two of our recent circuits. Unfortunately, he has not given a sufficiently full address to answer him by letter, so we are printing his letter, and our remarks, below. He writes:

"Having followed with interest your articles on the 1952 R. and E. Radiogram and the pre-amplifier in the April, 1952, issue of your journal, I have to make the following queries.

"I have built up the pre-amplifier using an EF37A, finding it all that you claimed. It has quite enough volume for room level listening, but I would like a little more in reserve. Would using a 6SN7 given me more gain, using the same method for compensation?

"Secondly, with regard to the 'R. and E. 1952 Radiogram,' I have on hand an ECH35, EBF32, 6J5, and two EN33s. What alterations to your circuit would be required with an output of 250 volts H.T. after smoothing to give the same response as the original circuit? As I have an Axiom 150 speaker reflex baffled, a high fidelity pick-up, and a number of L.P. records, I would like to do them justice by broadcast and gramophone, using these particular circuits."

We take it that "High-Fidelity" is referring to the pre-amplifier circuit used with the "78-L/P Special," which originally was designed for a 6AU6. Our suggestion is that if he has not enough output to load his amplifier fully, he should add a low-gain stage of amplification after the pre-amplifier tube. The additional stage could use a 6J5 or similar low-gain triode, resistance-coupled, and use a fixed voltage divider at its grid so that under no circumstances is the 6J5 overloaded, and so as to reduce the overall gain, which will now be too high.

Without performing some experimental work, or going into quite lengthy calculations, it is not possible for us to recommend exact values as "High-Fidelity" asks. These feedback amplifiers are designed as a whole, and complete satisfaction cannot be guaranteed if the valves are changed, or other modifications made, without proper testing of the new set-up. In cases like this, about the only thing that can be done is to change the values of load resistors, cathode resistors, etc., to suit the new valves, and then experiment with the feedback resistor to determine the suitable degree of negative feedback. Even this process may have a decided effect on the performance of the amplifier, and readers are recommended to adhere to our published designs wherever possible.

Do you use the "R. and E." Photographic Service? For details see advertisements in previous issues.

Missing or Stolen Radios

Criminal Investigation Branch, Auckland

H.M.V., serial No. 23143, five-valve broadcast, fitted with "B.S.R." 3-speed motor, 10 in. rubber covered turntable. Mahogany finished cabinet, size 16 in. x 18¼ in. x 12¼ in., stretched aluminium grille front, four tuning knobs.

"Golden Knight" 5-valve broadcast, veneer cabinet 20 in. x 16 in. x 9 in. Serial No. 577/33.

Motorola car radio, serial No. 7077. Control panel 2 in. x 2 in. x 8 in., metal container with pinkish paint finish, white plastic dial, pointer, red dots indicating dial range, cream plastic knobs for tuning. Speaker 9 in. x 7 in. x 5 in., metal container painted brown, brown plastic grille front. Connected to radio by short length of steel cable.

H.M.V. portable, battery-electric, 5-valve, plastic case 9 in. x 8 in. x 4½ in., either cream or red, large tuning knob at either end, gold coloured aluminium grille front, leather carrying handle on top of set. Serial No. 7007.

Paragon 5-valve, 20 years old, 16 in. x 9 in. x 12 in. dark stained plywood cabinet, 6 in. square speaker in centre, covered with grey art silk, bordered with thin wooden filigree beading, volume knob lower left, knob lower centre out of order, tuning knob lower right beneath brass dial.

Wayfarer car radio, 6-valve, single unit, serial No. 1892; 10 in. x 6 in. x 3 in. brown coloured metal case, brown coloured oblong dial, two white bakelite knobs at side dial for tuning and volume control, one black bakelite control switch underneath dial.

Aristocrat car radio, 12-volt, serial No. 1360. Long narrow dial, numbering 50 to 160. Two white knobs, 6 in. speaker set in bottom. Grey aluminium case 6 in. x 10 in. Seven-foot radio aerial, extension make. Back nameplate inscribed, "Sole N.Z. Distributors Todd Motors, Wellington."

Pacemaker, Model 5151, serial No. 81601, light brown mottled, size 8 in. x 12¾ in. x 6 in. Five-valve broadcast, glass slide rule dial, tone control switch back of chassis, 6 in. x 4 in. elliptical speaker.

Autocrat car radio, 8-valve, 12-volt, serial No. 6107. Light blue steel container, 9½ in. x 4½ in. x 3 in., brown dial 4½ in. x 2 in., numbered 55 to 150 with stations named. Dial has blue plastic front. Two white plastic knobs. Blue metal speaker, 7 in. x 4½ in., material front, white plastic tone control knob on front of perforated sides. Short length of steel cable for attachment to radio.

Mt. Eden Police Station:

Avalon 4-valve electric and battery portable, brown mottled metal case 9 in. x 5 in. x 5 in., wooden door at front, amberlight handle, two white control knobs, red switch. Dial marked 55 to 150, third of back hinged for access to batteries and power flex.

Criminal Investigation Branch, Christchurch:

Philips 6-valve portable, A.C. and D.C., model 654, serial No. 25467. Size 18 in. x 12 in. x 6 in., with plastic ribbed grille each side. Leather carrying handle. 1 in. wide oblong dial, two white control knobs front, one white control switch at side.

Police Station Whakatane:

Astor portable, 5-valve. Case cream bird's eye check, dials on top marked with Australian stations.

Police Station, Waipukurau:

Rolls 5-valve broadcast. "Patent Royalty" registration 5/12458, serial No. R.B.K. 142400. Cream coloured case 16 in. x 6 in. x 11½ in., with 6/9 elliptical speaker. Tone control knob broken and repaired by boring hole in centre and gluing nail in.

Criminal Investigation Branch, Palmerston North:

H.M.V. car radio, model 496 A.R., serial No. 15053. Black metal case, dial frame cracked on right hand corner and inside wiring altered to cut out part of set.

Criminal Investigation Branch, Wellington:

Columbus, model 501, serial No. 01258, 5-valve table model, brown wooden veneer cabinet.

Philips model 926, chassis No. 24320, 5-valve, no cabinet, complete in all details and in full working order. Size 12 in. x 6 in.

Police Station, Dunedin:

Philips portable, serial No. 1028, royalty No. 36678, model 545, A.C./D.C. 5-valve and rectified. Green leatherette covered case, cream facings on dial.

Radio Industry Award for Technical Writing

First of the Radio Industry Council's Premiums for technical writing—to be awarded to authors of technical articles deserving to be commended by the industry—has been won by Mr. J. R. Acton, B.Sc., Grad.Brit.I.R.E., of the Ericsson Research Laboratories, Nottingham.

The award of 25 guineas is made for an article on "The Single-pulse Dekatron" which was published in *Electronic Engineering* in February, 1952. The Dekatron he describes in his prize-winning article is a new type of gas-filled cold-cathode ray tube now being developed for use in scalers and computors.

Further awards of R.I.C. premiums will be announced at the end of the year, the plan being to award up to an average of six a year.

Mr. Acton, who lives at Bunny, Nottinghamshire, is 31 years of age, is married and has three sons. He was educated at St. Edmunds School, Canterbury, and took external honours in science at London University. Starting as a medical student, he had to abandon his chosen career owing to a serious illness and during the early years of the war joined the technical staff of A. C. Cossor Ltd., later transferring to the research department. In 1948 he joined the research department of Ericsson Telephones who were just starting comprehensive research into cold cathode tubes and he now has charge of research in this particular field.

Both Great Britain and the United States can claim independent invention of the Dekatron type of valve, Mr. Acton having been responsible for its invention in Great Britain, and the premium-winning article is based on a second major invention arising from further development. Mr. Acton is also conducting an independent research (sponsored by Ericssons) in the Physics Department at Nottingham University on collison cross-sections of metastable atoms.

Judges awarding the R.I.C. Premiums are:

Professor Willis Jackson, D.Sc., D.Phil., M.I.E.E., F.Inst.P., Professor of Electrical Engineering, Imperial College of Science and Technology, University of London.

Mr. P. D. Canning Chairman of the Technical Directive Board, R.I.C.

Mr. W. M. York, Chairman of the Public Relations Committee, R.I.C.

Mr. T. E. Goldup, M.I.E.E., a member of the Technical Directive Board, R.I.C.

Vice-Admiral J. W. S. Dorling, C.B., M.I.E.E., Director, R.I.C.

Writers of articles in papers abroad are reminded that they are eligible for awards.

Latest Record Releases

(Supplied through the courtesy of Messrs. H.M.V. (N.Z.), Ltd.)

Orchestral

The Fair Maid of Perth, Suite (Bizet): Royal Philharmonic Orchestra, conducted by Sir Thomas Beecham. Col. LX.8790/1.

Sur La Plage (On the Beach)—Waltz (Waldteufel): Philharmonia Orchestra conducted by Constant Lambert. Col. DX.1755.

Brandenburg Concerto No. 3 in G (Bach) (3 parts); Sarabande (from Partita No. 1 in B Flat) (Bach) (Liselotte Selbiger, Harpsichord), Chamber Orchestra of the Palace Chapel, Copenhagen, conducted by Mogens Woldike. HMV. C.3947/8.

Sinfonia from Cantata No. 42 ("Am Abend aber desselbigen Sabbaths") (Bach), London Chamber Orchestra conducted by Anthony Bernard. HMV. C.4069.

La Vestale—Overture (Spontini): London Symphony Orchestra, conducted by Fernando Previtali. HMV.

Pineapple Poll, Ballet (Sullivan arr. Mackerras): Sadler's Wells Orchestra, conducted by Charles Mackerras. Col. DX.8387/92 (Set C.216).

Variations on a Theme from Suite No. 3 in G (Tchaikovsky) (5 parts); Intermezzo from "Voyevoda" (Tchaikovsky), The Philharmonia Orchestra, conducted by Nicolai Malko. HMV. C.7826/8.

Rhapsodie Espagnole (Liszt arr. Busoni): Gina Bachauer, pianist, with New London Orchestra conducted by Alec Sherman. HMV. C.7854/5.

Symphony No. 91 in E Flat (Haydn) (5 parts); Tweve German Dances, Nos. 1 to 6 (Haydn): Danish State

Broadcasting Chamber Orchestra, conducted by Mogens Woldike. HMV. Z.7016/8. (12in. Plum.)

Concertos

Concerto for Violin and Orchestra (Walton): Jascha Heifetz, violinist, with Philharmonia Orchestra, conducted by William Walton. HMV. DB.9611/3.

Operatic and Light Operatic

Don Giovanni—Non mi dir, bell' idol mio (Donna Anna's Aria, Act 2) (Mozart) sung in Italian): Maria Cebotari, soprano, with Vienna Philharmonic Orchestra. HMV. DB.6738.

Marriage of Figaro (Mozart), Non Piu Andrai (Now no more); Aprite un Po' Quegli' Occhi (If men would look about them) (sung in Italian): Tito Gobbi, baritone, with Philharmonia Orchestra. HMV. DA.1946.

Orefeo Ed Euridice-Che Faro Senza (I have lost my Euridice) (Gluck); Alceste—Divinita Infernale (Ye powers that dwell below) (Gluck): Ebe Stignani, mezzo-soprano, with orchestra. Parlophone R.30002.

Instrumental

Waltz No. 14 in E Minor (Posthumous) (Chopin); Mazurka in C Sharp Minor, Op. 50, No. 3 (Chopin): Dinu Lipatti, pianist. Col. LX.1346.

Toccata (from Symphony No. 5 in F Minor) (Widor): Fernando Germani, organist. (Recorded in Westminster Cathedral). HMV. B.10018.

Vocal

Einsam Ging Ich Jungst, K.308 (Mozart); Die Kleine Spinnerin, K.531 (Mozart) (sung in German): Irmgard Seefried, soprano, with Gerald Moore at the piano. Col. LB.108.

Sweet Confessions (Ich muss dir was gesteh'n) (sung in German); Ik Hou Van Holland! (sung in Dutch): Joseph Schmidt, tenor, with orchestra. Parl. DP.227.

O Love that wilt not let me go: All that thrills my soul is Jesus: Scottish Festivals of Male Voice Praise (Massed Chorus of 200 voices). Parl. R.3255.

Dance Orchestral, Light Vocal, etc.

I had it but it's all gone now—F.T.; Kansas City Man Blues—F.T.: Sidney Bechet with Bob Wilber's Wildcats. Col. DC.559.

Douce France; Que Reste-t-il de nos amours: Charles Trenet, vocalist, with orchestra. Col. DCF.14.

Wee Hoose 'mang the Heather; We All Go Home the Same Way: Sir Harry Lauder, with orchestra. HMV. C.4093.

Cuban Holiday; Teddy Bears' Picnic: Tommy Reilly, harmonica, with rhythm accomp. Parl. R.3415.

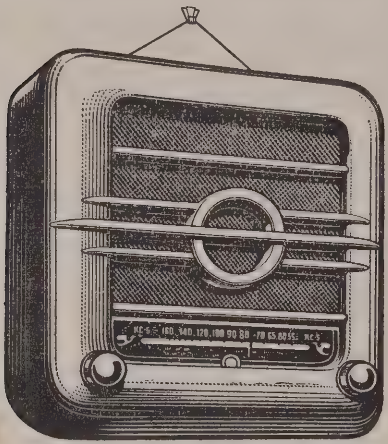
Light Orchestral

Show Boat Selection: Intro.: Cotton Blossom, Can't help lovin' dat man, Why do I love you? Make Believe, Can't help lovin' dat man, Bill, You are Love, Make believe, Ol' Man River): The Melachrino Orchestra. HMV. C.4103.

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

This section of our paper is reserved for the introduction of new products and space preference is given to our regular advertisers. Advertising rates are charged according to space occupied. For further particulars contact Advertising Manager, R. and E., Box 8022, Wellington.

THE NEW "ULTIMETTE"



The smart little radio receiver illustrated here is a brand new Ultimate product and is for New Zealand something quite revolutionary in character.

The "Ultimette" twin-purpose receiver is a compact little receiver which may be hung on the kitchen wall or, in fact, anywhere where a small broadcast set is required.

The set is forwarded with two small feet which may be attached to the base of the set when it is desired to use this as a table model receiver.

The main features of the new "Ultimette" are that it is a smart broadcast receiver employing a 5 in. speaker and styled so that it is convenient to pack in a suitcase and is therefore transportable from place to place.

It is considered that University students, people living in flats and rooms, occupants of offices, and housewives who are obliged to spend long hours in the kitchen, will find the new "Ultimette" wall set just what they have been waiting for.

The back plate of the receiver performs as a built-in aerial and provision has been made for the use of an outside antenna.

This set retails at £15 15s. and is immediately available.

* * *

CHALFONT ELECTRIC BED SHEET

His Master's Voice (N.Z.) Ltd., are pleased to announce the arrival of a shipment of "Chalfont" electric bed sheets, manufactured by Messrs. Chalfont Electrical Products Ltd., Leicester, England.

These sheets are available in two sizes, 60 in. x 33 in. suitable for both single and double beds, and 60 in. x 51 in. specially designed for double beds. The latter is fitted wtih the dual control system originated by Chalfont, separate switches being fitted to each side of the bed sheet, thus enabling each half to be controlled independently of the other. Both sizes are available with 3-speed or single heat.

The Chalfont electric bed sheet is the outcome of several years patient research directed towards the production of a hygienic, safe and durable bed heater. Earlier types of electric blankets and mattress overlays were designed for use beneath the sleeper, thus, not only being subjected to greater wear and tear, but also giving heat just where it was least needed. On a cold night the side on which one lies is warmer than the other. Therefore, under wintry conditions, extra blankets are placed above and not beneath the sleeper, for 80 per cent. of the heat lost from a bed is lost from the top surface. Used between the bed clothes which cover the sleeper, however, the Chalfont electric bed sheet not only warms both inner surfaces of the bed before the sleeper retires, but afterwards provides that extra heat just where it is most needed. In addition, there is no preparation—just the click of a switch, and in a short time the bed is delightfully warm all over.

Summer storage safe from dust and moths need cause no worry either when the Chalfont electric bed sheet is packed away in its attractive transparent container. Yes, there is also a guarantee of 12 months.

All inquiries should be directed to the Trade Division, E.M.I. Suppliers, P.O. Box 296, Wellington.

NEW RELEASES BY H.M.V. (N.Z.), LTD.

"PERTH"

5-Valve Broadcast Mantel Radio

"ARGYLE"

5-Valve Dual Wave Mantel Radio

These two new H.M.V. models will suit the newly-weds for the first radio in the new home. Styled in brown and cream toned bakelite cabinets the two models will enhance any surroundings into which they might be placed. Being in the "lower price" range both these attractive radios can be allowed for in the newly-wed's budget and can later on be used as "the extra radio" when finance permtis the purchasing of a radiogram.

"Perth"—Model 525A/BC

"Argyle"—Model 525/D

SPECIFICATIONS

Valve Complement:

(1) 7S7, mixer.
(2) 7B7, I.F. amplifier.
(3) 7C6, detector and first audio.
(4) 7C5, output.
(5) 7Y4, rectifier.

Frequency Range:

(1) Broadcast, 535–1540 kc/sec.
(2) Shortwave, 6–19 mc/sec. (Argyle model only).
(3) I.F. frequency, 455 kc/sec.

Power Supply

Mains, 230 volts A.C.
Power consumption, 50 watts.

Audio Output

Two watts.

Cabinet

Height, 9 in.; length, 13 in.; depth, 7 in.

CLASSIFIED ADVERTISEMENTS

WANTED TO BUY—*Electronics,* U.S.A., November, 1944, January, February, June, 1945, to complete our library. S.O.S. Radio Ltd., 283 Queen Street, Auckland.

FOR SALE—Capacitor analyser. Measurer capacity and resistance, £10. Clay, 48 Tireti Road, Titahi Bay, or 54-045.

A Cocktail Party

Mr. R. Allum (Allum Elec.), Mr. E. H. R. Green (P. & T.), Mr. Eversleigh (Nat. Broad.), Mr. L. Harrison (Nat. Broad.).

Mr. D. Brown (S.T.C.), Mr. P. England (Nat. Elec.).

"How said Solder."

Mr. W. G. Leatham, Mr. R. T. Wraight (Production Manager, Todd Motor Industries), Mr. G. A. Cuthbert (C. & B.). Mr. E. H. R. Green (P. & T.), Mr. Ralph Slade (Philips), Mr. E. L. Exley (Nat. Elec.), Mr. Martin Kimball (Colliers), Mr. W. D. Foster (R. & E.), Mr. Alex Ayton (R. & E.).

Some thirty representatives of radio and electrical trades and Government Departments were guests recently of Messrs. H. J. Enthoven and Sons, of London, England, at a cocktail party at the Hotel Waterloo, followed by the screening of Enthoven's 16-millimetre coloured motion picture film entitled "The Vital Link."

As readers are well aware, Messrs. H. J. Enthoven and Sons are makers of Superspeed activated cored solders and other related products.

The hospitality was excellent, and the film, in spite of its abstract subject-matter, proved exceptionally interesting and entertaining. Tracing the mining of tin and lead from the days of the Roman Occupation of Great Britain right through to the present time, the film went on to show the method adopted in the manufacture of today's highly successful activated cored solders. In the Enthoven laboratories, as well as in their three different works, all phases of the preparation and blending of the base metal to make the solder were shown, as were also the laboratoy tests to ensure the purity of the material, and lastly the actual extrusion of the final product, complete with core. Slow motion sequences were included, demonstrating the efficiency of the special core construction adopted in this solder. Final scenes showed this solder being used in the factories of many large and well-known firms in England.

Guests were presented with samples of "Whiteflash" and coloured flash solders, while the various packing methods adopted by this progressive firm were also on display.

Host at the party was Mr. W. G. Leatham, of Messrs. W. G. Leatham, Ltd., Wellington, New Zealand representatives of Messrs. H. J. Enthoven and Sons, Ltd.

When welcoming guests, Mr. Leatham expressed his principal's appreciation of the excellent support already accorded the solder in this country by both industry and Government departments.

Proceedings of the New Zealand Electronics Institute Incorporated.

Minutes of meeting of the Executive Council held in the office of the Secretary, A.M.P. Building, Wellington, on Tuesday, 2nd September, 1952, at 5.30 p.m.

Present—Chairman: Mr. W. L. Harrison (Dominion President); Wellington Councillors: Mr. L. W. Hurrell (Treasurer), Mr. J. D. McCormick; Combined Branch Councillor: Mr. W. D. Foster; Christchurch Branch Councillor: Sqdr. Ldr. A. L. Partelow; Dunedin Branch Councillors: Mr. W. L. Shield, Mr. H. F. Symmons (connected by telephone); Secretary: Mr. J. H. McIvor.

Present by Proxy: Mr. W. Shiel held a proxy for Mr. D. P. Joseph (Auckland Branch Councillor) and Sqdr. Ldr. Partelow held a proxy for Mr. B. Withers (Vice-President).

ELECTION OF OFFICERS

The following officers were duly nominated and declared elected:

President: Mr. B. Withers.
Vice-President: Mr. W. D. Foster.
Secretary: Mr. J. H. McIvor.
Treasurer: Mr. L. W. Hurrell.

APPOINTMENT OF SUB-COMMITTEES

(i) Admissions Committee.
Mr. P. C. Collier (to act for one year).
Mr. B. Withers (to act for one year).
Sqdr. Ldr. Partelow (to act for two years).
Mr. W. L. Shiel (to act for three years).

(ii) Membership and Publicity Committee.

It was agreed that the appointment of a Membership and Publicity Committee be put on the agenda for the next meeting. Resolved: "That the Council recommends to all Branch Committees that extreme methods be adopted to obtain material for publication in Institute Proceedings and other mediums of publicity." (Symmons/Shiel.)

Reference was made by the Dunedin delegates to the publicity accorded their recent activities by the local metropolitan newspaper.

(iii) Additional Committees.

Resolved: "That the appointment of further committees be considered at the next council meeting."

FINANCE

Accounts were approved for payment.

Mr. Shiel drew attention to the high cost per capita for printing and stationery.

Bank statement as tabled revealed a credit balance as hereunder:

This meeting, £236 13s. 11d. Last meeting, £160 17s. 11d.

The Secretary advised that 74 members of the 128 listed members of the Institute had paid their subscriptions, the amount received now totalling approximately £150, which revealed that 56 per cent. of the existing membership was financial.

CORRESPONDENCE

Letter from Wellington Branch, dated 9th August, 1952, re recognition of membership qualifications. On behalf of Wellington District, Mr. L. W. Hurrell advised that if the Institute could obtain recognition by Government Departments and industry of its present corporate membership qualifications, this would be of considerable benefit not only to the members but to the Institute itself. A case was cited by Mr. Shiel where by virtue of having an Institute qualification a member had received a salary increase of £12 10s. per year. Mr. Shiel undertook to forward further information in regard to this matter.

Resolved: "That a sub-committee consisting of Messrs. McCormick, Andrews, and Slade, be appointed to implement Wellington's recommendation, and be given power to act."

Letter from Dunedin Branch, dated 4th August, 1952, re resignation of Dunedin Branch members, etc. Considerable discussion ensued in connection with this letter and it was felt that every effort should be made for a visit by the President and Vice-President to Auckland and Dunedin, with a view to taking action on some of the matters mentioned in the Dunedin Branch letter.

Resolved: "That Council receive the letter from Dunedin Branch and investigate fully and at the earliest opportunity, the matters contained therein." Note: It was clear from the discussion on this item that the setting up of a Membership and Publicity Committee would automatically ensure that the most important points would receive every attention, bearing as they do on the problem of increasing Institute membership.

Letter from Mr. H. F. Symmons, dated 27th June, 1952, re constitutional amendments. Resolved: "That Messrs. McIvor and Symmons be appointed a sub-

committee with power to act in furtherance of the proposed constitutional amendments." The Secretary undertook to send Mr. Symmons a copy of the draft circular letter to be dispatched to all members for postal ballot before final approval. A suggestion that a rule be added providing for ex officio Council membership for immediate past Presidents was approved in principle.

GENERAL

Representation at D.S.I.R. meeting covering Survey of Scientific Manpower. Sqdr. Ldr. Partelow asked what action had been taken to arrange for the Institute to be represented at the D.S.I.R. meeting covering a Survey of Scientific Manpower. It was agreed that Council record their disapproval of the non-representation of the Institute at this meeting.

Rutherford Memorial.—The President advised that the Institute had been represented at meetings covering the Rutherford Memorial Appeal, and no doubt an official invitation would be extended very shortly to the Institute to hear a lecture to be delivered by Sir John Cockroft.

Authority for payment of telephone link-up with Dunedin. Resolved: "That the Secretary be authorized to pay the account yet to be received from the Telephone Branch covering the cost link-up with Dunedin."

Next meeting date. Resolved: meeting be held on Tuesday, 14th O

This concluded the business of the ose at 8.25 p.m.

Measuring Radio Frequencies

(Continued from Page 21.)

monic can be used to tune up any circuits that should tune to signal frequency, with the oscillator left strictly alone. When this is done, the oscillator can be tuned round to find if it is on the high or the low side of the signal frequency.

These examples could be extended to fit several other cases, and readers will no doubt find many such for themselves. They do, however, serve to illustrate one method of making use of a signal generator outside its nominal frequency range.

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and Ships—Metal Work

(Continued from Page 23.)

The same procedure is followed right round the chassis, except that the last fold will require a block of wood cut to exact size to fit inside the two opposing chassis sides. The next step is to cut four pieces of aluminium about 1½ in. x ½ in. from the waste cut from the corners of the sheet and fold them at the centre of their length to right angles. These pieces can be fitted in each corner of the chassis to hold the ends together and can be held by either small bolts or rivets. One is shown fitted in position in Fig. 3.

The next step consists in cutting out the valve holes, etc, Small holes are easily drilled but the bigger ones are more difficult. Excellent punches are available for this purpose fairly cheaply, but the job can be done by scribing out the size of the hole to be cut, drilling a ¼ in. hole at the centre, and then filing it out with a round coarse file. The hole can be finished off with a half-round file until the right size and a neat job is achieved. For power transformers it is recommended that upright mounting type be used since no large cutouts are required; if a flat mounting type must be used, the only real way of cutting out the square hole is to drill a series of small holes round the piece to be cut out and then remove it by cutting through the pieces still holding with a pocket knife. The edges of the hole must then be filed true with a flat file. This is a rather slow process, but gets there in the end and there you are making chassis to your own special requirements!

When you become really proficient at the job, dial movements and metal boxes can be made also, thus saving pounds. From time to time more and better tools can be obtained until a good workshop is built up for tools are always a very real asset.

Wellington Traders' Association

(Continued from Page 31.)

DEATH OF MR CHARLES FRANCIS (CHRISTCHURCH)

Before the conclusion of the meeting, the Secretary was instructed to send a letter of sympathy to the relatives of the late Mr. Francis, a former President of the New Zealand Radio Traders' Federation.

Radar Techniques

(Continued from Page 20.)

PRACTICAL CONSIDERATIONS

Although the above discussion applies to both pulsed and continuous-wave magnetrons, the former type used exclusively in radar aplications. In such usage, a rectangular voltage pulse is applied between the cathode and anode of the magnetron. This voltage has a peak amplitude ranging from about 3 kilovolts to over 60 kilovolts for different magnetrons. For convenience, since it is difficult to isolate the anode from the output transmission line and antenna parts, the anode is usually grounded and the cathode is pulsed *negatively*.

The duration of the voltage pulses is usually very short, ranging in different applications from about one-quarter to ten *microseconds*. These pulses are applied at regular intervals called the *pulse repetition rate*. Pulse rates ranging from 200 to 5,000 p.p.s. are commonly used. The product of the pulse duration in microseconds and the pulse rate in p.p.s. is called the "duty cycle." This factor defines the ratio of time the magnetron is oscillating to the time it is off. Many radar magnetrons operate at 1,000 p.p.s. and a pulse duration of 1 microsecond, or a duty cycle of .001. This means that the magnetron is "on" only 1/1,000th of the time. The *peak* current drawn during the pulse may be of the order of tens or even hundreds of amperes, although the *average* current as indicated by a D.C. meter in series with the magnetron would be much lower, being the peak current times the duty cycle for esentially rectangular pulses.

A *performance plot* of a typical pulsed magnetron is shown in Fig. 7. It shows the power output and efficiency of the magnetron as a function of applied peak current and voltage for various fixed values of magnetic field. From such data, the radar designer can select an appropriate operating point to meet given requirements. Notice that power output and efficiency increase with increasing the magnetic field. The shaded area indicates regions of instability due to internal arcing.

Although the modern magnetron has been instrumental in extending the limit of efficient radio frequency generation at least one hundred times, it is encountering the same kind of limitations above 30,000 megacycles which confine conventional triodes to the frequencies below 300 megacycles.

Philips Experimenter

(Continued from Page 25.)

The clamp-tube method is not the only one by which screen modulation can be effected. There is no reason why a small power amplifier should not be transformer-coupled to the screen of an R.F. amplifier, and indeed, with some valves, whose screen power is larger than that of others, this is the better way, since transformer coupling does not waste a good deal of the available audio power in the plate load resistor. It is possible, too, that a circuit in which a separate screen voltage supply was used, together with an audio choke for applying the modulator's H.T. voltage, would have advantages in certain cases. This would substitute a choke for the transformer, but would limit the choice of valves suitable as modulators for a given R.F. amplifier, since the matching would then be dependent solely on the load resistance needed by the modulator, and the load actually supplied by the screen circuit. With the transformer, of course, any power valve can be matched to the screen circuit.

(To be continued.)